1 of 1

Clean Coal II - PFBC Utility Demonstration Project

Annual Report

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**For
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TABLE OF CONTENTS

	<u>Page No.</u>
1.0 EXECUTIVE SUMMARY.	1
2.0 INTRODUCTION AND BACKGROUND.	1
2.1 Project Summary.	2
2.2 PFBC Technology Overview	2
2.3 Plant Description and Technical Information.	7
2.3.1 PFBC Island	7
2.3.2 Steam Cycle Description	9
2.3.3 Gas Cycle Description	9
2.4 Modified Cooperative Agreement	9
3.0 PROJECT OBJECTIVES	11
3.1 Overview of Objectives	11
3.2 Budget Period 2 Objectives	11
3.3 Budget Period 2 Accomplishments.	14
3.3.1 Value Engineering Studies	14
3.3.1.1 Preliminary System Description. . .	14
3.3.1.2 Preliminary Analysis of Fuel Feed Systems	17
3.3.2 Sorbent Utilization Improvements - Fines Admission System	18
3.3.2.1 System Goals.	19
3.3.2.2 Description/Design Basis.	20
3.3.2.3 Engineering and Design Assignments	20
3.3.2.4 Permitting Requirements.	20
3.3.2.5 Installation and Start-Up.	20
3.3.3 Contracts Awarded	24
4.0 REPORTS TO THE DOE.	24
5.0 MAJOR MILESTONES AND PROJECT SCHEDULE	26
6.0 OUTLINE OF WORK FOR 1993	28
6.1 PFBC Systems Test.	28
6.2 PFBC Systems Optimization/Scale-Up	28
6.3 Load Growth Projection	28
7.0 CONCLUSION	28

FIGURES

1.	PFBC Utility Demonstration Project - Work Breakdown Structure.	3
2.	Plant Locations.	4
3.	PFBC-001: Greenfield Plant.	5
4.	Sporn Plant-Simplified PFBC Combined Cycle	6
5.	Tidd PFBC Combustor Assembly	8
6.	PFBC-001 Water and Steam Composite Cycle	10
7.	Budget Period 2 Major Activities Schedule.	13
8.	Combustor Assembly Scale Up.	15
9.	Sorbent Fines Admission System Schematic	21
10.	Sorbent Fines Admission System Project Schedule.	22
11.	Sorbent Fines Admission System Pre-Op Schedule	23
12.	PFBC-001 Project Schedule - Mountaineer Site	27

TABLES

1.	1992 Reporting Requirements.	25
2.	Major Milestones and Plant Data.	26

BIBLIOGRAPHY

29

APPENDICES

1.	Budget Period 2 Tasks.	30
2.	Scope of Contracts	32
3.	Abbreviations and Acronyms	34

1.0 EXECUTIVE SUMMARY

This is the second Annual Report submitted to the Department of Energy (DOE) in connection with the Cooperative Agreement between the DOE and the Appalachian Power Company (APCO) for the Pressurized Fluidized Bed Combustion (PFBC) Utility Demonstration Project.

The report covers the period January 1, 1992 to December 31, 1992; during which time, Task 1.1.3 (Value Engineering) was started. Task 1.1.3 as well as continuation of Task 1.1.2 (Project Support) are associated with Budget Period 2 (BP2) of the Cooperative Agreement.

BP2 tasks, which extend from January 1992 to January 1996, are aimed at reducing the technical and economic risks of a large commercial PFBC plant. This objective is being met by performing value engineering activities and testing various systems, including a sorbent fines admission system. Installation of this system (at the Tidd PFBC Demonstration Plant) started in December 1992. The sorbent system being installed is for the purpose of a process verification. Hardware costs specific to verification activities are being funded under the PFBC Utility Demonstration Project Cooperative Agreement. Test data is dependent upon operation of the Tidd facility.

A contract was awarded to the Babcock and Wilcox Co. to perform engineering studies for the 340 MW PFBC plant. Submittal of deliverables as required by the contract is proceeding slightly behind schedule due to delay in award of the contract.

During 1992, reports were submitted to the DOE as specified in the Cooperative Agreement. These included the draft of a revised Project Management Plan for Phase 1 and the Project Evaluation Plans for BP2.

The present PFBC program identifies the year 2004 for completion of the project at an as-spent total shared cost of approximately \$918 million.

A major goal for 1993 is to conclude the Value Engineering Task, and submit a topical report to the DOE. The report will provide a basis for American Electric Power Service Corporation (AEPSC), as agent for subsidiary companies of American Electric Power Company, Inc. (AEP) and the DOE to reevaluate the PFBC Utility Demonstration Project.

2.0 INTRODUCTION AND BACKGROUND

AEPSC has been pursuing development of PFBC technology in an effort to use coal in a more cost effective and environmentally acceptable manner. The first major step towards demonstrating this technology in the United States was achieved by constructing and operating the Tidd PFBC Demonstration Plant in Brilliant, Ohio. The next step involves erection of a large scale commercial plant.

AEP initiated preliminary activities for the commercial PFBC plant in order to submit a proposal to the DOE in response to the Program Opportunity Notice for emerging clean coal technologies. The proposal which was one of

those selected by the DOE for negotiation resulted in execution of a Cooperative Agreement between AEP and the DOE. Additional information including DOE's participation and selection process for the project is detailed in the "Comprehensive Report to Congress - Clean Coal Technology", dated February 1990.

The commercial size PFBC plant is titled PFBC Utility Demonstration Project (or PFBC-001). The project is divided into major tasks as identified in the Work Breakdown Structure (WBS), Figure 1. The Value Engineering Task (Task 1.1.3) was started during 1992 and will continue through most of 1993.

2.1 PROJECT SUMMARY

The program for PFBC-001 examined the application of the technology to repower the 330 MW Sporn Units 3 and 4 and to develop a stand-alone Greenfield power plant. The Sporn Repowering option studied the replacement of the two pulverized coal-fired boilers with a single PFBC combustor/gas turbine module. This option would utilize the plant's existing major facilities but would also require addition of several PFBC-related facilities and systems. The Greenfield PFBC plant study developed a stand-alone 340 MW facility on an undisturbed site. During the Greenfield study, a parallel study was undertaken to identify candidate PFBC plant sites. The parallel study identified four potential PFBC plant sites based on the following siting criteria:

- o Engineering/Economic
- o Sociological
- o Environmental

Upon completion of the field studies, the sites were ranked according to the data compiled. The Mountaineer site (a greenfield site) had the highest ranking of the four sites. A life cycle cost analysis was performed on the Repowering and Greenfield options. The results of this analysis concluded that the Greenfield options were more economically viable than Sporn Repowering, and of the Greenfield options, the Mountaineer site was more economically viable. A location map of the existing Tidd PFBC Demonstration Plant, the Sporn site and the Mountaineer site is depicted in Figure 2. An artist rendering of a Greenfield plant layout is depicted in Figure 3.

2.2 PFBC TECHNOLOGY OVERVIEW

PFBC technology allows for a more efficient generation of electricity by taking advantage of a combined cycle operation. In this technology, combustion occurs at a temperature of approximately 1580°F and pressure of 232 psia within a fluidized bed of ash, sorbent (dolomite or limestone) and coal. Boiler tubes immersed in the bed serve as the medium for heat transfer to the steam cycle and production of steam to drive a steam turbine. The gases exiting the combustor are subsequently expanded in, and used to drive a gas turbine then they exhaust through the stack. Ninety percent (90%) or more of the sulfur is removed by the sorbent during combustion while NO_x formation is minimized due to the low combustion temperature. A simplified flow diagram of a PFBC combined cycle (based on repowering Sporn) is shown in Figure 4.

PFBC Utility Demonstration Project
Work Breakdown Structure

Figure 1

PLANT LOCATIONS

Figure 2

PFBC - 001: GREENFIELD PLANT

Figure 3

Figure 4
Sporn Plant Simplified Combined Cycle

The development of PFBC technology to commercialization has undergone a logical progression since its inception in the late 1960's at the National Coal Board (NCB) Coal Utilization Research Laboratory (CURL) in Leatherhead, England. For over fifteen years, AEPSC and ASEA Brown Boveri (ABB) have worked together through each phase of research and development culminating in the design and construction of the 70 MW Tidd PFBC Demonstration Plant. Details of the Tidd PFBC Demonstration Plant are presented in the "Public Final Design Report", dated October 1992.

AEPSC's support of long term PFBC testing is aimed at resolving issues associated with the technology including; in-bed tube erosion and corrosion, gas turbine blade erosion-corrosion, gas cleaning, fuel injection and overall process control.

Since 1983, ABB Carbon's "Component Test Facility" has been instrumental in providing answers to many of these questions. However, testing of a true combined cycle at Tidd is providing both design and operation of a commercial scale PFBC plant. A drawing of the Tidd combustor vessel and pertinent steam data is depicted in Figure 5.

2.3 PLANT DESCRIPTION AND TECHNICAL INFORMATION

The major aspects of the PFBC plant are summarized below. Additional details are covered in the "PFBC Utility Demonstration Project 1991 Annual Report" dated November 1992.

2.3.1 PFBC Island

The main components of the PFBC Island are the combustor assembly, gas turbine, economizer, fuel feed and ash removal systems. The combustor assembly for the 340 MW plant consists of the pressure vessel together with the internals including the fluidized bed enclosure, in-bed heat transfer surface, cyclones, bed ash reinjection vessels and necessary platforms. The estimated size of the combustor assembly is approximately 60 feet in diameter by 130 feet high.

The fuel preparation system allows for crushing and screening of raw coal and feeding the appropriate size material to the coal water paste (CWP) mixers to provide a 25% water-by-weight CWP. From the mixers, the CWP is transferred to a CWP surge tank and then fed to the combustor by the fuel injection pumps. Sorbent is crushed, dried and fed pneumatically to the combustor through sorbent feed nozzles.

Cyclone ash is removed by means of direct pressured reduction system and the bed ash is removed via lockhoppers and conveyed to the bed ash silo.

The gas turbine is a two-shaft machine with a fixed speed high pressure compressor and high pressure turbine (driving a generator) on one shaft, and a variable speed low pressure compressor and low pressure turbine on the other shaft. Downstream of the low pressure turbine is the economizer to transfer waste heat from the gas turbine exhaust to the feedwater.

TIDD PFBC COMBUSTOR ASSEMBLY

Figure 5

Ohio Power Company
Tidd PFBC
Demonstration Plant
Brilliant, Ohio

Capacity, lb Steam/h	440,600
Superheater Outlet Pressure, psi	1,310
Superheater Outlet Temperature, F	925

2.3.2 Steam Cycle Description

Figure 6 shows a schematic of the water and steam composite cycle. Condensate from the condenser hotwell is transferred to the deaerator via the hotwell and condensate booster pumps. From the deaerator, the feedwater is pumped through the feedwater heaters and economizers to the combustor.

Main steam leaving the combustor at 3675 psi and 1000°F supplies the high pressure steam turbine. The exhaust of the high pressure turbine flows to the reheat portion of the PFBC combustor then to the intermediate pressure steam turbine, the low pressure steam turbine and finally to the condenser.

2.3.3 Gas Cycle Description

The air/gas cycle uses a GT-140P turbine, which pressurizes ambient air to sixteen atmospheres. The high pressure air flows to the fluidized bed where combustion occurs at 1580°F. Gases from the fluidized bed go through the cyclones and then to the gas turbine to drive the compressors and a 70 MW generator. The gases then go through the economizer and precipitator and then exhaust through the stack.

2.4 MODIFIED COOPERATIVE AGREEMENT

The original Cooperative Agreement which was executed in April 1990 was modified in 1992. A summary of the modification which was incorporated by executing Amendment No. A006 is as follows:

- o The total estimated period of performance for the project was extended to 166 months.
- o The number of budget periods was increased to seven.
- o Mountaineer Plant replaced Philip Sporn Plant as the site for the project place of performance.
- o The application of the technology changed from repowering to Greenfield.
- o The total estimated project cost was revised to approximately \$918 million as-spent through year 2004.
- o DOE cost sharing remained at \$184 million; however, the percentage decreased from 28% to 20% based on the revised estimated cost of the project and the fact that DOE's cost share remained at \$184 million.
- o A provision for the DOE to terminate or withdraw from the project during Budget Period 2 was added.
- o A new article was added as follows: "Pending Public Utility Commission approval, AEP agrees that the next baseload plant constructed in the Appalachian Power Company service area in response to load growth, will be a coal-fired pressurized fluidized bed combustion unit with minimum capacity of 330 MW."

- o The statement of work was updated to include additional tasks 1.1.3 (Value Engineering), 1.1.4 (Grassroots Preliminary Engineering and Design) and 1.1.5 (Project Review).

3.0 PROJECT OBJECTIVES

3.1 OVERVIEW OF OBJECTIVES

The overall objectives of AEPSC on the PFBC Utility Demonstration Project are as follows:

- o Engineer, design and construct a 340 MW PFBC unit such that it will operate safely, reliably and efficiently.
- o Implement the project in accordance with the schedule and within the authorized budget.
- o Demonstrate the cost effectiveness of the PFBC technology in achieving significant reduction of SO₂ and NO_x emissions when compared to a pulverized coal-fired plant with scrubbers.
- o Ensure compliance with all regulatory, federal, state and local agency permitting and licensing requirements.
- o Develop a generic engineering and design approach (to the extent practical) for use on future PFBC applications at other sites.
- o Optimize building and equipment modules, and maximize pre-assembly off-site fabrication.
- o Ensure that AEP's experiences on the Tidd PFBC Demonstration Project are integrated into the planning, engineering, design, procurement, construction and operation of Project PFBC-001.

The above objectives are consistent with the intent of the original Commercial PFBC project; however, the performance of these objectives are based on the modifications to the Cooperative Agreement as outlined in Section 2.4 of this report.

3.2 BUDGET PERIOD 2 OBJECTIVES

Budget Period 2 (BP2) is a continuation of Phase 1A tasks. Phase 1A provided for preliminary design of a PFBC repowering application for the Philip Sporn Plant. Because the PFBC application changed from repowering to greenfield, Budget Period 2 was structured to provide for preliminary design of a greenfield plant. In addition, during Budget Period 2, AEPSC will conduct value engineering activities aimed at reducing the technical and economic risks associated with a commercial plant. Budget Period 2 extends from January 1992 to January 1996. The objectives of BP2 are based on tasks 1.1.3, 1.1.4 and 1.1.5 as described in the Budget Period 2 Continuation Application dated September 19, 1991. A description of these tasks is incorporated in this report as Appendix 1.

Basically, BP2 tasks are aimed at improving the technical and economic viability of the large size PFBC commercial plant by means of an engineering and design optimization program. The major activities associated with the BP2 are shown in Figure 7.

PFBC UTILITY DEMONSTRATION PROJECT-BP2 MAJOR ACTIVITIES SCHEDULE

Figure 7

3.3 BUDGET PERIOD 2 ACCOMPLISHMENTS

3.3.1 Value Engineering Studies

The PFBC Island for the Tidd PFBC Demonstration Plant was provided by ASEA Babcock (AB), a partnership between The Babcock & Wilcox Co. (B&W) and ABB Carbon (ABBC). When the PFBC Utility Demonstration Project was planned, AB was also intended to be the technology supplier for the PFBC Island. However, subsequent to the initiation of the work for this project, the business relationship between ABBC and B&W was changed, and B&W became a licensee of ABBC for PFBC technology in the United States, replacing AB. In accordance with the statement of work set forth for the current budget period, contract C-8821 was issued to B&W to conduct value engineering studies for the scale up of the PFBC Island for the PFBC Utility Demonstration Project. Appendix 2 summarizes the scope of work for B&W.

As part of the deliverables for the contract, B&W provided AEPSC a set of generic system descriptions covering their current reference design for a P-800 plant. While the information contained in the system descriptions is proprietary and confidential, the following is a summary of non-proprietary information concerning the reference plant design.

3.3.1.1 Preliminary System Description

The proposed plant will be a logical scale up of the design used at the Tidd PFBC Demonstration Plant. The focal point of the design is to replicate proven systems and components, by increasing the number of components rather than physically increasing the size of the components where possible.

o Pressure Vessel

The pressure vessel is a scale-up of the Tidd design. The vessel internals are arranged with the boiler in the lower portion, the bed reinjection vessels directly above the boiler, and the cyclones in the upper portion of the vessel. A schematic of the combustor assembly scale up over the years is depicted in Figure 8.

o Boiler

The boiler design has several enhancements above the current design used at Tidd. It has a single non-rectangular bed with multiple compartments and several parallel circuits. It allows for fixed and/or sliding pressure operation, and incorporates reheat circuitry.

o Gas Cleaning System

The gas cleaning system is based on using eighteen parallel strings of cyclones, with first and second stage cyclones. The size of the cyclones is virtually the same as that used at Tidd. The basic approach is similar to that used at Tidd, with some refinements concerning the distribution piping system to and from the cyclones.

COMBUSTOR SCALE UP

COMMERCIAL
2000's
800 MWt
16 ATM

TIDD
1990 -
200 MWt
12 ATM

CTF
1982 -
15 MWt
12-16 ATM

LEATHERHEAD
1969 - 1982
2 MWt
6 ATM

Figure 8

- o Combustor Depressurization System

The proposed design is based on a hot blow off system, which includes a method to bypass the gases from the gas turbine, and cool the hot gases. Although not unexpected, this is different from Tidd. Throughout the design of the Tidd Plant, the combustor depressurization approach was constantly debated. While a system to depressurize the hot gases was deemed superior with respect to the auxiliary systems, the inability to obtain a reliable high temperature valve prevented implementation of a hot blow-off system. Utilization of a cold blow-off system at Tidd imposed several requirements concerning the auxiliary feedwater system, combustor cooling system, and nitrogen system.

- o Bed Preheating

The bed preheating system is basically a scale-up of the bed preheating system used in the Tidd design.

- o Fuel Preparation System

The preparation of fuel to support a dry or a wet feed system is under consideration. The fuel preparation system uses a hammer mill to prepare the coal for a dry feed system, or a roller mill, as is used at Tidd, for a coal water paste (CWP) feed system. It includes redundancy, and has the capability to mix the sorbent with the coal as determined by other design considerations.

- o Fuel Injection System (Dry)

The dry fuel injection system for the reference plant is designed to handle mixed coal and sorbent of a specified size and moisture content. It uses lockhoppers and a prepared inert gas as the transport medium for the pressurized pneumatic feed. Each fuel injection vessel supplies two pneumatic feed lines, each with a dedicated fuel injection nozzle.

- o Fuel Injection System (CWP)

The CWP fuel injection system is a scale-up of the Tidd fuel injection system, with 36 injection points as opposed to six injection points for Tidd. The CWP feed lines penetrate the combustor vessel from below rather than from the side as at Tidd.

- o Sorbent Injection System

The sorbent injection system is a pneumatic dry feed system based on a scale-up from Tidd. It is comprised of two injection towers with adequate redundancy to supply twelve sorbent injection nozzles. Tidd contained two injection nozzles.

- o Bed Ash Removal System

The bed ash removal system is scale-up based on the design used at Tidd. It is comprised of six parallel lock hopper strings.

- o Bed Reinjection System

The bed reinjection system is a scale-up from the Tidd design. Six bed reinjection vessels are used.

- o Gas Turbine

The gas turbine is the ABB Stal GT140P design. It is based on the Tidd GT35P design and the commercially available GT120 design. It uses two in-line shafts. The high pressure turbine and compressor shaft are connected to the generator via a reduction gear, and the low pressure turbine and compressor shaft are free spinning. An intercooler is installed between the low pressure compressor and high pressure compressor.

The gas turbine is started by operating the generator as a synchronous motor by means of a frequency converter. However, an oil-fired auxiliary combustor is also used during start-up in order to minimize the size (and cost) of the frequency converter, and the electric demand of the motor during start-up.

- o Economizer

The economizer is a modular, finned-tube design with multiple circuits as required to support the configuration of the cycle. Based on experience from Tidd, the economizer will require sootblowers.

3.3.1.2 Preliminary Analysis of Fuel Feed Systems

As part of the contract, B&W and ABBC conducted an analysis which compares a dry feed system to a coal water paste (CWP) system for the PFBC Plant. Some of the findings identified in the analysis include:

- o Feed Points

The dry feed system leads to a higher temperature gradient in the bed. Therefore, more fuel feed points are required with a dry feed system.

- o Crushers

The dry feed system requires a less expensive hammer mill to crush the coal, compared to a roller mill as is required for a CWP system. The roller mill is required for the CWP system because of the importance of the size consist for the CWP.

- o Injection

Lockhoppers are required for a dry feed system, and the fuel nozzles are relatively inexpensive. The CWP system requires more expensive paste pumps, CWP storage tanks, and the fuel nozzles are much more complex than for a dry feed system.

o Impact on Plant Availability

Experience has been gained with both the dry feed system at the Escatron Plant and the CWP feed system at the Tidd and Vartan Plants. It is expected that the CWP system will result in a higher availability than the dry feed system.

The study concluded that the CWP feed system would result in lower capital costs, higher plant availability, and smaller space requirements than a dry feed system.

3.3.2 Sorbent Utilization Improvements - Fines Admission System

As part of value engineering, a sorbent fines admission system was designed and installation was started in 1992 at the Tidd Plant to verify the overall sorbent utilization improvements which are a prerequisite for the commercial viability of PFBC.

During tests performed at Tidd to date, the sulfation of the cyclone ash calcium has been about 40-45%. The sulfation of the cyclone ash is an indication of the utilization of the sorbent fines, which are under 60 mesh in size. It is theorized that the low degree of sulfation of the fines at Tidd is due to poor distribution of the sorbent in the bed via the two pneumatic feed points. While the coarse particles stay in the bed and thus move around, the fines are believed to be passing out of the bed in two plumes without having time to react with the SO_2 . These concentrated fines readily deplete the SO_2 concentration near the plumes, thus resulting in calcium under-utilization as they pass out of the bed. Better distribution of the fines would provide better contact and thus better utilization.

As part of the value engineering studies to achieve better distribution, the sorbent fines system design incorporates adding sorbent fines to the coal water paste, and then feeding the CWP to the combustor via coal injection lines. The coarse material would continue to be fed via the pneumatic sorbent injection system. Feeding of the sorbent fines via multiple injection points will actually provide significantly better distribution than if multiple pneumatic feed points were used. The reason for this is that the fines will stick to the paste lumps which move around in the bed. While the fines will not react until they break away from the paste lumps, they will be distributed across the bed. Another benefit is that the fines will be released in close proximity to where the coal is burned and thus where the SO_2 concentration is highest. It is anticipated that better than 60% calcium utilization of the fines can be achieved with this feed method.

The reason for not putting all of the sorbent in the coal is the increased water requirements which would reduce plant efficiency. While adding sorbent fines to the paste will require some additional water that will reduce efficiency, indications are that this may be an appropriate commercial plant design.

The sorbent fines system design (which is developed for a process verification) is designed to accurately meter sorbent fines at a rate proportional to the coal preparation rate, as measured by the existing coal weigh feeder. The percentage of the sorbent that is fines will be varied in order to determine optimum sorbent feed conditions, thus the sorbent to coal

ratio will be varied. The design basis for the major components of the process design verification equipment are outlined below.

- o Outside Storage Silo:

The outside storage silo is designed to store 500 tons of sorbent fines. This capacity is based on having enough sorbent fines readily available at the site to bring the unit up to load, stabilize operation at full load for 24 hours then run a test for 48 hours at full load (assuming a 6 ton/hour sorbent fines feed rate at full load, 50% of total sorbent). Adequate sorbent fines storage precludes the need for just-in-time delivery which would be difficult to set up given the intent to vary suppliers and product sizes. The storage silo will be filled via a bulk truck fill connection. There is sufficient capacity in the existing sorbent handling system to store in excess of 500 tons of corresponding coarse material.

- o Transport System:

A 20,000 lb/hr pneumatic transport system will be used to feed the sorbent fines into the surge bin located inside the combustor building. This system will operate in an on/off mode via high and low level switches on the surge bin. The transport line will be 4" in size.

- o Vent System:

The bin vent filter will be sized to vent transport air from the fill truck and from the pneumatic feed system to the unit. The surge bin will be vented back to the storage silo via a 5" line. This is being done since space limitations inside the combustor building prohibit installation of a separate filter on the surge bin.

- o Inside Surge Bin:

Due to space limitations and the building steel arrangement, the inside surge bin is limited to 4'-6" in diameter. The surge bin has a capacity of approximately 8 tons.

Additional information will be provided in a topical report which will be prepared following full operation of, and data collection from the system. Characteristics and requirements of the system are as follows:

3.3.2.1 System Goals

The goals of the sorbent fines admission system are to verify increase sulfur retention and improve the overall sorbent utilization. It is theorized that a large amount of the fines are being wasted as they separate and collect in the cyclones without ever reacting with SO_2 . By mixing sorbent fines in the coal paste, the sorbent distribution will be improved and sorbent utilization and sulfur retention should increase resulting in reduced operating costs of the commercial PFBC plant.

Process verification testing at Tidd will consist of controlling the calcium-to-sulfur (Ca/S) ratio and measuring sulfur retention with an ultimate goal of obtaining 95% sulfur retention at a Ca/S ratio of 1.8 using dolomite. Tests will be conducted by injecting a coarse sorbent fraction, using the existing sorbent injection system and mixing sorbent fines into the coal paste to determine the optimum sorbent fines fraction. It is also planned to test different types of sorbent including limestone (and probably bed ash or cyclone ash assuming the ash contains some unreacted sorbent) to evaluate other potentials for improving sorbent utilization.

3.3.2.2 Description/Design Basis

The sorbent fines admission system schematic is depicted in Figure 9. It consists of a 500-ton sorbent fines storage silo, an 8-ton surge bin, rotary gates, a belt weighfeeder, a conveying air blower, a bin vent filter, a sampler, piping, valves, instrumentation and controls.

3.3.2.3 Engineering and Design Assignments

The structural and mechanical engineering and design of the sorbent fines admission system (except for reinforcement of the existing combustor building steel) were performed by the Smoot Company. The engineering and design tasks for the associated electrical systems, the instrumentation and controls system; the review of Smoot Company's drawings; and the reinforcement of the existing combustor building steel were performed in-house by AEPSC.

3.3.2.4 Permitting Requirements

On the basis of environmental consideration, the sorbent fines admission system is categorized as a fugitive dust emission source. Consequently, a permit to install (PTI) and a permit to operate (PTO) the system were required; the necessary permit applications were submitted to the Ohio EPA (OEPA) on October 6, 1992. The OEPA issued the PTI on November 25, 1992, and will issue the PTO during 1993 following completion of construction.

3.3.2.5 Installation and Start-Up

United Construction Company, Inc. (UCCI), sub-contractor to Smoot Co., mobilized on site November 30, 1992, and started site work on December 1, 1992. As of December 31st, UCCI has completed placement of the foundation for the 500-ton silo and installation of the major components inside the combustor building.

United Electric of Wheeling mobilized on site December 14 and is proceeding with installation of grounding and conduits.

Initial start-up of the sorbent fines admission system is scheduled for 1993, as depicted in Figure 10 (Project Schedule), and Figure 11 (Pre-Op Schedule). Data collection from the system is subject to operation of the Tidd Plant.

Figure 9

PFBC-001:SORBENT FINES ADMISSION SYSTEM-PROJECT SCHEDULE

Figure 10

PFBC-001:SORBENT FINES ADMISSION SYSTEM-PREOP SCHEDULE

Figure 11

3.3.3 Contracts Awarded

Contract C-8817 was awarded to the Smoot Company on July 14th to perform the engineering, design and equipment fabrication pertinent to the structural and mechanical scope of work for the sorbent fines system. Following evaluation of competitive bids, the contract was amended to incorporate the structural and mechanical erection. The associated work is proceeding on schedule.

Purchase order 07420-020-2X was issued to United Electric of Wheeling, Inc., on October 7th to perform the electrical installation for the sorbent fines system. The associated work is proceeding on schedule.

Contract C-8821 for performance of engineering optimization studies was awarded to the Babcock and Wilcox Company on August 17th. The contractor has started to submit reports associated with the studies; however, the submittals have been proceeding later than planned.

A summary of the scope of work for the contracts awarded in 1992 is discussed in Appendix 2.

4.0 REPORTS TO THE DOE

All reports and deliverables were submitted in accordance with the Cooperative Agreement. Six of the eight different types of reports were submitted according to the established monthly, quarterly or yearly frequencies. Submittal of the other two deliverables were based on the Special and Additional reporting provisions of the Cooperative Agreement. These are the:

- o Project Evaluation Plans
- o Budget Period 2 Project Management Plan

As of December 1992, the Project Management Plan was being finalized to accommodate comments received from the DOE earlier in the year. Table 1 depicts the 1992 reporting requirements.

Table 1

PFBC Utility Demonstration Project
1992 Reporting Requirements

ITEM NO.	DESCRIPTION	FREQUENCY	DRAFT/DOE APPROVAL REQUIRED	STATUS	DATES DUE TO DOE - 1992											
					JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.	Federal Assistance Milestone Plan (EIA-4598)	O X Q	No	Sch Act	01/30/92 01/20/92			04/30/92 04/22/92			07/30/92 07/27/92			10/30/92 10/16/92		
3.	Federal Assistance Management Summary Report (EIA-459C)	O M	No	Sch Act	01/20/92 01/07/92	02/20/92 02/07/92	03/20/92 03/12/92	04/20/92 04/10/92	05/20/92 05/07/92	06/20/92 06/15/92	07/20/92 07/16/92	08/20/92 08/17/92	09/20/92 09/18/92	10/20/92 10/16/92	11/20/92 11/25/92	12/20/92 12/18/92
4.	Federal Assistance Program/Project Status Report (EIA-459F)	M	No	Sch Act	01/20/92 01/07/92	02/20/92 02/07/92	03/20/92 03/12/92	04/20/92 04/10/92	05/20/92 05/07/92	06/20/92 06/15/92	07/20/92 07/16/92	08/20/92 08/17/92	09/20/92 09/18/92	10/20/92 10/16/92	11/20/92 11/25/92	12/20/92 12/18/92
5.	Financial Status Report (SF 269)	M	No	Sch Act	01/20/92 01/07/92	02/20/92 02/07/92	03/20/92 03/12/92	04/20/92 04/10/92	05/20/92 05/07/92	06/20/92 06/15/92	07/20/92 07/16/92	08/20/92 08/17/92	09/20/92 09/18/92	10/20/92 10/16/92	11/20/92 11/25/92	12/20/92 12/18/92
7.	Technical Progress Report	Y	Yes	Sch Act												
	Final			Sch Act												
	a. Reproducible Master Copy			Sch Act												
	b. Hard Copy			Sch Act												
13.	Project Evaluation Plans (based on budget periods)	A	Yes													
	Draft			Sch Act				04/14/92 03/26/92								
18.	Federal Cash Transactions Report (SF 272)	M	No	Sch Act	01/20/92 01/07/92	02/20/92 02/07/92	03/20/92 03/12/92	04/20/92 04/10/92	05/20/92 05/07/92	06/20/92 06/15/92	07/20/92 07/16/92	08/20/92 08/17/92	09/20/92 09/18/92	10/20/92 10/16/92	11/20/92 11/25/92	12/20/92 12/18/92
23.	Project Management Plan (based on defined budget periods)	O A	Yes													
	Draft			Sch Act			03/02/92 03/26/92									
	Final			Sch Act												12/21/92

REPORTING FREQUENCY CODES:

Code Definition: A As required, C Financial Asst.Chg., F Final, * See Cooperative Agreement for special requirements.

Code Definition: M Monthly, O Once after award, Q Quarterly, S Semi-annually, X With application, Y Yearly

Sch - Schedule
Act - Actual

5.0 MAJOR MILESTONES AND PROJECT SCHEDULE

A comparison of the previous major milestones and plant data with the current PFBC program (as approved by Amendment A006 to the Cooperative Agreement) is shown in Table 2. The overall schedule for the commercial PFBC Plant at the Mountaineer site is depicted in Figure 12.

Table 2

Major Milestones and Plant Data

<u>Item</u>	<u>Previous</u>	<u>Current</u>
Participant	APCo	APCo
Plant Capacity (MW)	340	340
Location	WVa	WVa
Project Start Date	April 1990	April 1990
Start Construction	March 1995	June 1999
Complete Construction & Demo Tests	September 1998	November 2002
Complete Commercial Demonstration	December 1999	January 2004
Project Complete Date	January 2000	February 2004

PFBC-001 PROJECT SCHEDULE - MOUNTAINEER SITE

Figure 12

6.0 OUTLINE OF WORK FOR 1993

The major task planned for 1993 is outlined in Appendix 1 (Task 1.1.3). It includes continuation of the Engineering Optimization Studies and evaluating the factors influencing the start of preliminary engineering and design for the 340 MW commercial PFBC plant at the Mountaineer site. The following is an outline of activities relevant to Task 1.1.3.

6.1 PFBC SYSTEMS TEST

This item includes testing the sorbent fines admission system at Tidd Plant after completion of construction.

6.2 PFBC SYSTEMS OPTIMIZATION/SCALE UP

This activity relates to the studies being performed by Babcock and Wilcox under Contract C-8821. It will also include in-house review of coal, sorbent and ash handling systems and other PFBC-related system requirements prior to the start of preliminary engineering and design.

6.3 LOAD GROWTH PROJECTION

AEPSC plans to deliver a report to the DOE by the end of 1993 outlining AEP's updated load growth projection and any recommended changes to the PFBC Program.

7.0 CONCLUSION

The Cooperative Agreement was modified in January 1992 to allow for development of an optimized design and cost estimate package for the 340 MW PFBC Commercial Plant. In support of this goal, contracts were awarded to Babcock and Wilcox to perform engineering optimization studies and to Smoot Company to design and install a sorbent fines admission system at the Tidd Plant. The objective of this system is to increase sulfur retention and improve the overall sorbent utilization.

During the next year (representing year two of the four-year Budget Period 2) the optimization studies will continue and additional tests will be performed. By the end of the year AEP expects to update its load growth projection to determine the need for new power generation. This will provide a milestone for reevaluation of the PFBC program by AEPSC and the Department of Energy.

BIBLIOGRAPHY

American Electric Power Service Corporation. Tidd PFBC Demonstration Project. Public Final Design Report. NTIS Publication DOE/MC/24132-3195 (DE93000234). October 1992.

American Electric Power Service Corporation. PFBC Utility Demonstration Project. 1991 Annual Report. NTIS Publication DOE/MC/26304-3194 (DE93000233). November 1992.

U.S. Department of Energy. Comprehensive Report to Congress. Clean Coal Technology Program. PFBC Utility Demonstration Program. NTIS Publication DOE/FE-0159. February 1990.

APPENDIX 1

Budget Period 2 Tasks

In addition to Task 1.1.2 (Project Support WBS1.1A.2) the following tasks will be performed during Budget Period 2.

Task 1.1.3 - Value Engineering (WBS 1.1A.3)

AEPSC shall work closely with the PFBC technology supplier to apply value engineering to the design of the PFBC Island in order to reduce the technical and economic risk factors associated with the scale-up of the technology to a 340 MW Plant size. The value engineering shall review bed dynamics to ensure that the optimal scale-up criteria is applied to ensure optimal process performance. As part of this effort, improved sulfur retention and reduced sorbent requirements shall be addressed.

AEPSC shall establish the need for, and provide to DOE a methodology of any verification testing required to support this effort, including tests at Tidd or another suitable facility, such as testing the reheat approach for the project at the Tidd PFBC Demonstration Plant. AEPSC shall also review the design of the PFBC systems to optimize the cost, efficiency, and redundancy of the PFBC systems. Operational experience from Tidd and other operating PFBC Plants shall be taken into consideration during this effort.

AEPSC also expects to incorporate the experience gleaned from the Tidd Hot Gas Clean Up Program to pursue the viability of incorporating Hot Gas Clean Up into the design of the commercial PFBC Plant. Further, AEPSC will explore using advanced high pressure high temperature steam conditions to improve the plant efficiency.

Task 1.1.4 - Preliminary Engineering and Design (WBS 1.1A.4)

Upon completion of the above effort, AEPSC shall develop an optimized site specific design and cost estimate package for a complete 340 MW PFBC commercial plant. Heat and mass balances, general arrangements, flow diagrams, and a detailed cost estimate will be developed for the plant.

Task 1.1.5 - Project Review (WBS 1.1A.5)

The design and cost estimate from above effort will be reviewed to establish the commercial viability of a 340 MW PFBC unit. Upon completion of this effort, AEPSC reserves the right to adjust the schedule for the subsequent budget periods based on AEP's forecasted need for base-load coal fired capacity at that time. Further, based on the cost estimate developed, AEPSC reserves the right to request additional cost-sharing from the DOE in accordance with the terms of the Cooperative Agreement.

AEPSC shall work with the necessary state regulators to obtain appropriate regulatory treatment for the Project consistent with the development nature of the Program.

AEPSC will establish specific goals in its Budget Period 2 Project Evaluation Plan to be used as a measure of accomplishments achieved during the budget period. Those goals will include the following:

- o That the estimated cost for the plant is economically competitive, compared to a pulverized coal fired plant with fluidized gas desulfurization and scrubbers.
- o That reheat is viable for PFBC.
- o That 95% sulfur retention can be achieved at a calcium to sulfur ratio of less than 1.8.
- o That Hot Gas Clean Up can be incorporated into the design of the plant using advanced particle filters.

AEPSC will provide to the DOE the following deliverables in addition to the deliverables stated in the Federal Assistance Reporting Checklist:

- o A program for verification testing of the reheat approach and 95% sulfur retention.
- o A comprehensive report which provides the methodology, data, and the results of the verification tests.
- o Preliminary system descriptions for the PFBC systems.
- o A report on the viability of incorporating Hot Gas Clean Up (HGCU) into the design of the plant. The report will include arrangement drawings which show how HGCU would be incorporated into the plant design and an economic analysis of using HGCU as opposed to the present design without HGCU.
- o At the end of the budget period, AEPSC will deliver to the DOE the complete design package for all plant systems, including System Process Sketches, System Design Basis Documents, PFBC System Descriptions, General Arrangement Drawings, Electrical Drawings, and Preliminary Controls drawings, as well as the detailed cost estimate in accordance with the Scope of Work Document prepared for the project.
- o By December 1, 1993, the Participant will deliver a report to the Department of Energy which provides an updated projection of its load growth. This report will provide an updated analysis of AEP's need for new generation, and recommended changes to the Program Schedule, based on the analysis. This will provide a convenient milestone for reevaluation of the program by AEPSC and the Department of Energy, and for redirection of the program (acceleration, deferral, cancellation) as appropriate.

APPENDIX 2

Scope of Contracts

The following is a summary of the scope of work for the contracts issued in 1992 as part of the Budget Period 2 activities.

Item #1 Sorbent Fines Admission System

(Contract: C-8817; Contractor: Smoot Co.)

1.1 Engineering and Design including:

- o Development of general arrangement drawings.
- o Preparation of design and erection details needed to construct the facility shown in Figure 3.

1.2 Equipment/Material Supply including:

- o Components as shown in Figure 3 (excluding sampler).
- o All motors required for the system.
- o Concrete and foundation embedments for the 500-ton storage silo and outside pipe support structure.

1.3 Construction including:

- o Placement of foundations
- o Installation of equipment as identified under Section 2.2 (above)

Item #2 Electrical Construction - Sorbent Fines Admission System

(P.O. #07420-020-2X; Contractor: United Electric of Wheeling, Inc.)

2.1 Install grounding as shown on Smoot Company drawings.

2.2 Install electrical systems as identified on AEPSC drawings for the sorbent fines admission system.

Item #3 PFBC Studies

(Contract: C-8821; Contractor: Babcock & Wilcox Co.)

3.1 Perform engineering optimization studies for the 340 MW PFBC plant essential technical areas including:

- o Development of system descriptions for a generic P800 PFBC Island design.
- o Study of coal feed system to include:
 - dry vs. paste feed
 - fuel preparation requirements
 - recommended number and location of fuel feed points
 - fuel feed train design relative to space requirements and orientation of the coal and sorbent feed train
- o Study of the mixing in a P800 PFBC fluidized bed and investigation of the bed behavior by testing cold scale models.
- o Development of a bed sampling system.
- o Performance of a quantitative prediction of the ash split between the ash separated from the top of the bed and the bed ash.
- o Recommended design of the P800 boiler bottom based on comparison of a water-cooled flat bottom air distributor versus the sparge tube design.
- o Analysis of hot versus cold "blow-off" systems.
- o Analysis of the cyclone ash removal system to develop a system layout based on theory and available experience.

3.2 Provide drawings reports and recommendations associated with each study area.

APPENDIX 3

Abbreviations and Acronyms

PFBC	Pressurized Fluidized Bed Combustion (also referenced as PFBC-001)
DOE	Department of Energy
APCo	Appalachian Power Company
BP2	Budget Period 2
AEPS	American Electric Power Service Corporation
AEP	American Electric Power
WBS	Work Breakdown Structure
ABBC	ASEA Brown Boveri Carbon
CWP	Coal Water Paste
B&W	Babcock & Wilcox
OEPA	Ohio Environmental Protection Agency
PTI	Permit to Install
PTO	Permit to Operate

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