AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100

Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

DOE/MC/24132-3745
(DE94004119)

TIDD PFBC Demonstration Project

**Quarterly Report
January - March 1994**

April 1994

Work Performed Under Contract No.: DE-FC21-87MC24132

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
American Electric Power Service Corporation
Columbus, Ohio

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

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 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, recommendation, or favoring 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.

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, 175 Oak Ridge Turnpike, Oak Ridge, TN 37831; prices available at (615) 576-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161; phone orders accepted at (703) 487-4650.

TIDD PFBC Demonstration Project

**Quarterly Report
January - March 1994**

Work Performed Under Contract No.: DE-FC21-87MC24132

**For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
P.O. Box 880
Morgantown, West Virginia 26507-0880**

**By
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215**

April 1994

TABLE OF CONTENTS

	PAGE
GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT	ii
I. INTRODUCTION AND SUMMARY	1
II. DESIGN AND PERMITTING	2
A. Engineering and Design Division	2
B. Environmental Engineering Division	4
C. Testing	5
III. PROJECT SUPPORT	8
IV. TIDD PFBC PLANT OPERATIONS	9
A. Operations	9
B. Maintenance	22
V. MANPOWER REPORT	25
VI. COST DATA - <i>removed</i>	26

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

AARP	Annunciator Alarm Response Procedures
AB	ASEA Babcock - A business partnership between a subsidiary of ABBC and the Babcock & Wilcox Company (USA)
AEP	American Electric Power Company, Inc.
AEPSC	American Electric Power Service Corporation, a subsidiary of AEP
AFC	Approved for Construction
AFL	Approved for Layout
ABBC	ABB Carbon - a subsidiary of ASEA-Brown Boveri (subcontractor)
AOP	Abnormal Operating Procedure
B&W	The Babcock & Wilcox Company (subcontractor)
BWCC	The Babcock & Wilcox Construction Company (subcontractor)
BOP	Balance of Plant
CBI	Chicago Bridge and Iron, Inc. (subcontractor)
CSWD	Cable Schematics Wiring Drawings
CTF	Component Test Facility
DOE	Department of Energy (United States)
DRC	Design Review Committee
E&SC	Electrical Equipment Service Corporation (subcontractor)
ECP	Engineering Control Procedure
EMP	Environmental Monitoring Plan
EOP	Emergency Operating Procedure
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
FAT	Net 90 - Factory Acceptance Test
GSU	Generator Step-up Transformer
GT	Gas Turbine

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

HPT	High Pressure Tubine
HVAC	Heating, Ventilating & Air Conditioning
I&C	Instrumentation & Control
IOI	Initial Operating Instructions
LPT	Low Pressure Turbine
MCR	Material Control Record
MCS	Management Command System
MCC	Motor Control Center
MED	Mechanical Engineering Division
NDE	Nondestructive Examination
NEMA	National Electric Manufacturers Association
NOP	Normal Operating Procedure
NOVAA	North Ohio Valley Air Authority
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
OCDO	Ohio Coal Development Office - a part of Ohio Department of Development
OPCo	Ohio Power Company
PES	Plant Electrical Systems
PFBC	Pressurized Fluidized Bed Combustion
PMP	Project Management Plan
POPS	Plant Operations and Performance System
ppb	Parts Per Billion
PTI	Permit to Instal
PTO	Permit to Operate
PWHT	Post Weld Heat Treatment

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

RDR	Request for Drawing Revision
RFQ	Request for Quotation
SD-0	System Description (Rev. 0)
SD-1	System Description (Rev. 1)
SD-2	System Description (Rev. 2)
SD-2.5	System Description (Rev. 2.5)
SD-3.0	System Description (Final)
SPCC	Spill Prevention Control & Countermeasures

I. INTRODUCTION AND SUMMARY

This is the 28th Technical Progress Report submitted to the Department of Energy in connection with the Cooperative Agreement between the DOE and the Ohio Power Company for the Tidd PFBC Demonstration Plant. This report covers the period from January 1, 1994 to March 31, 1994.

Major activities during this period include:

- The unit operated for 850 hours on coal, bringing the grand total for coal fire through the end of the quarter to 6318 hours.
- The unit availability for the first quarter was 40.1%.
- There were twelve gas turbine starts, eight bed preheater starts, and six operating periods on coal.
- During this quarter, total gross generation was 40,721 MWH, the peak unit output for one hour was 62 MWH, and the coal consumption was 19,370 tons.
- Three performance tests were conducted during this quarter.
- The plant was able to remain in service during the sub-zero weather in January, providing power to the critically short grid.

Major items planned for the next period include:

- Continuation of sorbent utilization tests at various bed levels and sulfur retention values.
- Finalize the agreements with the DOE, Ohio Coal Development Office and technology suppliers for funding for an additional year of operation.

II. DESIGN AND PERMITTING

A. Engineering and Design Division

- **Boiler**

Babcock & Wilcock was commissioned to perform a study to evaluate possible methods to reduce the effective in-bed tube bundle heat absorption to permit the unit to operate at full bed height during the summer months when the gas turbinecompressor air delivery capacity is reduced due to high ambient temperatures. Only methods which are easily restorable are being considered. The present focus is on tube shielding.

On January 29, 1994 the unit was taken out of service due to an exceedingly high temperature on one of the evaporator outlet legs. Inspection revealed that the cause was a tube leak. Erosion of the north sidewall tubes just above the top of the start-up zone insulation liner near the mandoor resulted in a tube leak in one of the waterwall tubes that, in turn, steam washed two nearby evaporator tubes causing them to leak. The cause of the initial side wall erosion is believed to be a leaking mandoor; however, ash bridging between the end evaporator circuits and the sidewalls was considered as a possible contributing factor. In an attempt to eliminate such bridging which was typical, the stainless steel lined upper portions of the start-up zone insulation system were removed from both sidewalls and the lower ceramic tile sections were capped off with castable refractory. This was done since the ash bridging was believed to be caused by the excessively warped stainless steel liner sections, which had blocked off much of the open space between the end evaporators and the sidewalls. It was also deduced that this change would help even out the evaporator circuit heat absorption imbalance which typically has a number of the evaporator circuits nearest the sidewall running in saturation. In spite of these changes the ash bridging still occurs and there has been no noticeable change in the heat transfer to the sidewall evaporator circuits.

As a result of the increased splitting air flow rates associated with the recent reimplementation of the dual stage splitting air nozzle design and the desire to

increase fuel splitting to mitigate sintering, the bed temperature balance between the front and rear wall shifted to where at full bed height the rear wall bed temperatures were well above those along the front wall. In an attempt to combat this problem, the "skateboards" were moved rearward in the bed by 8 inches. This change had the desired effect at full bed height; however, at lower bed heights it resulted in the front wall temperatures exceeding that of the rear wall.

- Bed Sintering

During this quarter numerous attempts were made to achieve sustainable full bed height operation at normal bed operating temperatures; however, excessive egg sinter formation continued to be an obstacle. The introduction of increased splitting air flow was to no avail. With the advent of warmer ambient temperatures, the high bed height/ firing rate testing, which is where sintering has been pervasive, will be precluded until this fall. As such, testing of potential resolutions to the sintering problem will likely be put off at least until then.

- Sorbent Utilization

The free board SO₂/ O₂ sample points were relocated in order to provide more information about the size of the SO₂ plumes above the fuel nozzle outlets. A number of the sample points were placed at varying locations within 1-2 feet of the plan centerline of the No. 2 fuel nozzle skateboard. Data from these locations indicate that the regions of high SO₂ concentrations are oval shaped with the longest dimension of 2-3 feet being aligned front to rear. Sampling will continue.

- Gas Turbine

Gas turbine LPC reassembly was completed at the beginning of this quarter. Cracked stationary guide vanes had been found by a borescope inspection in December of 1993. Five guide vane rings were replaced.

- Sorbent Injection

In order to test improvements in sorbent utilization, the sorbent injection system was modified during this quarter. The original two-point distribution system in the bed was increased to a four-point distribution system with the installation of a ceramic lined piping system. This system splits each of the two line flow in the combustor vessel into two more lines, thus giving the four-point distribution. This splitter piping is installed inside the combustor vessel, between the combustor wall and the boiler.

- Primary Ash Removal System

As the unit continues to operate at high loads, the internal primary ash coolers are experiencing operation at high temperatures due to the higher ash loadings. As a result, the grafoil gaskets in the coolers are experiencing a higher failure rate and require higher maintenance. Currently, the internal ash cooler return chamber end cap gaskets require replacement every four outages. This is necessary in order to minimize the air in leakage into the system. A major replacement program is being planned for these gaskets in the future when outage time permits.

B. Environmental Engineering Division

- All monthly and quarterly environmental monitoring reports were filed with the North Ohio Valley Air Authority and Ohio EPA, as required.
- The DOE's Environmental Monitoring Plan (EMP) requires quarterly reports be filed within sixty days of the quarter's end. In compliance with that requirement, the EMP Quarterly Report for the Fourth Quarter (October - December) of 1993 was submitted to DOE in late February 1994.
- The EMP annual report for 1993 was submitted to DOE at the end of March, 1994. The annual report is a summary of the four quarterly monitoring reports for 1993 and is required to be submitted within 90 days of the year's end.

- Monitoring of solid, liquid, and gaseous waste streams, as required by the operations phase of the EMP, was performed throughout the quarter. Results of the monitoring will be included in the first quarter EMP report due to DOE at the end of May 1994.

C. Testing

- The following three performance tests were conducted during this reporting period:
 - Test 45: 1/18/94 115" bed level, 90% SR, 1540°F bed temp.
 - Test 46: 1/19/94 115" bed level, 90% SR, 1540°F bed temp.
 - Test 47: 1/21/94 115" bed level, 90% SR, 1500°F bed temp.

All tests were conducted with Pittsburgh No. 8 coal and Plum Run Greenfield dolomite and utilizing the original two point sorbent injection system. The bed ash production test for Test 45 was aborted due to the extreme cold weather conditions causing coal and sorbent handling problems. Temperatures dropped to -21°F the morning of 1/19/94. Test 46 was a repeat of Test 45 and included evaluation of bed ash production. Test 47 was conducted at a reduced bed temperature.

Sorbent requirements were ten to fifteen percent better than baseline tests using Pittsburgh No. 8 coal and P.R. G. dolomite, and slightly improved over recent tests conducted using four sorbent feed points. It is possible that the improved sorbent utilization is due to a finer grade of sorbent being produced due to recent changes made in the sorbent crusher speed. The surface mean diameter (SMD) of the sorbent during Tests 45 through 47 was approximately 430 microns with 41% less than 60 mesh. Typical sorbent sizes have been 460 to 500 microns SMD with 30 to 35% less than 60 mesh. Testing will be conducted during the fourth year of Tidd operation to evaluate the effect of using four sorbent feed points and finer sorbent together.

Figure 1: Tidd Test Data

	TEST NUMBER		45	46	47
	TEST DATE		01/18/94	01/19/94	01/21/94
	TEST PERIOD		800-1500	800-1600	0000-0700
OPERATING DATA					
n/a	BED LEVEL (CALC)	INS	114.5	114.2	114.2
886	ST GEN MW	MW	41.2	40.0	37.6
885	GT GEN MW	MW	11.8	11.7	11.0
n/a	COAL PASTE FLOW (CALC)	PPH	58096	57000	55852
217	MEAN BED TEMP	F	1538.1	1532.7	1498.8
691,692	INT VALVE INLET TEMP	F	1374.7	1379.9	1358.8
191	AVERAGE BED OUTLET O2	%	6.2	5.5	5.7
260	MEAN CYCLONE INLET TEMP	F	1399.1	1405.8	1383.1
604	AIR FLOW	KPPH	705.2	658.2	627.2
864	FEEDWATER FLOW (MVS)	KPPH	341.6	336.5	319.3
EMISSIONS					
710	SO2 LVG ESP (RAW)	PPM	177.1	198.1	196.0
709	NOX LVG ESP (RAW)	PPM	145.4	139.0	144.5
n/a	NOX LVG ESP (CALC)	LB/MMBTU	0.27	0.25	0.26
n/a	SO2 LVG ESP (CALC)	LB/MMBTU	0.51	0.54	0.55
FEEDSTOCK ANALYSIS					
	COAL SULFUR	WT. PCT. (D/B)	3.52	3.61	3.28
	COAL SULFUR	LB SO2/MMBTU	5.47	5.54	5.07
	PASTE MOISTURE	WT. PCT. (A/F)	25.42	26.83	28.33
	SORBENT CaO	WT. PCT. (D/B)	28.18	28.45	28.24
	SORBENT SMD (from ELH)	MICRONS	433	427	435
CALCULATED RESULTS					
	FIRING RATE	MWT	163.6	159.3	152.0
	SULFUR CAPTURE	PERCENT	90.6	90.2	89.1
	Ca/S TEST	-----	2.21	2.13	2.22
	Ca/S @ 90%, 1580 TBED	-----	1.97	1.92	1.94
	Ca/S @ 95%, 1580 TBED	-----	2.56	2.50	2.52
	COAL FLOW (DRY)	PPH (D/B)	43328	41707	40029
	TOTAL SORBENT FLOW	PPH	20890	19730	18010
	SORBENT IN PASTE	PERCENT	0.0	0.0	0.0

Table 1

III. PROJECT SUPPORT

Major Projects Division (MP) continues to process significant purchase requisitions required to support construction or maintenance related work. Additional activities by MP include identifying of changes to segments of the Project Management Plan associated with the extended duration of the Phase III task. These changes will be finalized after the revised "Statement of Work" is developed.

IV. TIDD PFBC PLANT OPERATIONS

A. Operations

The following is a summary of accumulated operating data for the period January 1, 1994 through March 31, 1994:

Steam Turbine Generation	32,403 MWH
Gas Turbine Generation	8,318 MWH
Total Gross Generation	40,721 MWH
Peak Generation for 1 Hour	62 MWH
Total Oil Fire Operating Time	58 Hours
Total Coal Fire Operating Time	850 Hours
Total Coal Injected	19,730 Tons
Total Sorbent Injected	7,297 Tons

During this quarter, the unit operated for a total of 850 hours of coal fire, bringing the grand total for coal fire hours to 6,381. The gas turbine operating hours total is now 8,363. In addition, the steam turbine has been in operation this quarter for 867 hours which corresponds to a unit availability of 40.1% for 1994 through March 31st.

There were twelve gas turbine starts, eight bed preheater starts, and six operating periods with coal fire. The peak gross output of 62 MWH was for the period of 1200 - 1300 hours on March 17, 1994.

The Hot Gas Clean Up system was in service for the entire quarter. Spoiling air was used on #11 primary cyclone to increase the mean ash particle size to the APF. Tempering air was used to limit the APF temperatures.

All performance tests were conducted with Pittsburgh #8 coal and Plum Run Greenfield #57 dolomite.

1. Start-Up TD-SU-94-01-01 January 8 - 11, 1994

The purpose of the run was to achieve a 500 hour run without blinding the APF. This was to be accomplished by limiting the APF temperatures to 1400 °F. Spoiling of #11 primary cyclone was also planned to increase the particle size of the ash to the APF. A secondary goal was to evaluate the effects of secondary splitting air and the modifications to the primary splitting air tube on the bed dynamics.

Warming of the combustor began on January 8th. The gas turbine was rolled at 1229 hours, paralleled at 243 hours and the gas turbine valves opened and air flow established through the combustor at 1258 hours on January 9th.

Due to outside air temperature of 4 °F low temperatures were experienced on the gas turbine intercooler until air flow was established through the combustor. During air preheating the primary and secondary splitting air flows were measured and adjusted.

Oil fire was established at 2310 hours on January 9th. Due to low outside air temperature the minimum speed air flow was 317 kpph.

Prior to coal fire #23 secondary ash line plugged at the economizer orifice. The orifice was rodded out and the ash line functioned well for the remainder of the run.

While bed preheating #14 primary cyclone ash line plugged. Air flow was increased and the higher differential pressure across the ash line succeeded in blowing the line clear.

The steam turbine was rolled and paralleled at 0457 hours on January 10th. A coal fire was initiated at 0641 hours on January 10th. Air flow was increased, the freeboard mixing steam system placed in service, and sorbent injection started at 0824 hours. Spoiling air to #11 primary cyclone was placed in service.

Bed level was then increased using 274 system. Once through boiler operation was achieved at 1447 hours January 10th. The bed level was then increased to 115 inches and maintained there for the start up sand to purge out through the bed drains.

At 0030 hours on January 11th, #13 primary cyclone ash line plugged. After trying unsuccessfully to unplug it by stopping the sorbent injection system and increasing pressure vessel pressure the combustor was tripped at 0136 hours. After cooling the bed the gas turbine was removed from service at 0308 hours on January 11th.

Inspection of the primary cyclones during the outage revealed sinters in the diplegs. Too much splitting air flow during start-up was determined to be the cause. Coal carryover to the cyclones due to over splitting resulted in coal concentration in the dip leg.

Following the removal of the bed material and cooling of the combustor the unit was released for maintenance outage work.

2. Start-Up TD-SU-94-02-01 January 14 - 29, 1994

The purpose of the run was to reach full bed height at 1540 degrees bed temperature without causing unstable bed conditions from sinters. A continued goal was to stabilize the differential pressure across the APF by limiting the temperature of the gas to the APF and by increasing the mean ash particle size by spoiling #11 primary cyclone.

In anticipation of extreme cold outside air temperatures, the condensate system was circulated and warmed to 90 °F and the circulating water inlet valves were set to minimize flow prior to the combustor release. Because of this prewarming of the condensate, the air warming of the combustor progressed quickly and the gas turbine intercooler temperatures were significantly higher during the gas turbine rolling than on the last start up even though the outside air temperature was -4°F.

The gas turbine was rolled at 1215 hours, paralleled at 1231 hours and the gas turbine valves opened at 1241 hours on January 15th.

During the air preheating time the primary and secondary splitting air flows were checked and balanced.

Following an oil fire at 1912 hours the steam turbine was rolled and paralleled at 2304 hours on January 15th.

Coal fire was initiated at 2344 hours on January 15th. Air flow was increased, freeboard mixing steam was placed in service and sorbent injection started at 0055 hours on January 16th. Spoiling air was placed in service to #11 primary cyclone after the air flow had been increased.

Bed level was increased and once through boiler operation was achieved at 0535 hours on January 16th. Bed level was then increased to 115 inches and maintained there while the start up sand was purged from the bed. After the bed had matured a performance test was conducted at 115 inch bed level, 1540 °F bed temperature and 90% sulfur retention from January 17th through 19th.

On January 20th size distribution and dust loading tests were conducted on the APF inlet and outlet gas streams.

Bed temperature was lowered to 1500 °F and another performance test conducted on January 21st.

Sinter accumulations in the bed and tube bundle continued to cause problems. By January 24th erratic and localized high bed temperatures and high evaporator tube temperatures indicated an unacceptable bed sintering situation. Attempts were made to "shake" the sinters loose and remove them from the bed. Bed level was reduced to 45 inches then increased back to 115 inches. This activity helped the symptoms but the improvements were short lived. Splitting air flow was increased from 3200 pph to 3500 pph to try to reduce sinter production.

On January 26 bed conditions had deteriorated to marginal again. The bed level was again reduced, this time to 28 inches and then raised back to 115 inches. Some improvement was seen in the bed conditions over night.

At 1020 hours on January 27th bed level was increased to 140 inches with bed temperature at 1510 °F. The tempering air for the APF was placed in service at 13.6 kpph flow. At 1251 hours on

January 28th bed temperature was raised to 1540 °F and the APF tempering air flow increased to 20 kpph to maintain the APF temperature below 1400 °F.

Once again sintering became a problem. On January 28th bed level was decreased to 120 inches and bed temperature lowered to 1520 °F. These conditions were held to try to clean up the bed.

A tube leak developed in the boiler and the combustor was manually tripped at 2031 hours on January 29th. Outage inspection found one water wall tube leak and two evaporator tube leaks caused by the water wall leak.

The gas turbine tripped at 2035 hours on January 29th due to high fictive disc temperature. The combustor was cooled, bed material removed and the combustor released to maintenance for outage work.

3. Start-Up TD-SU-94-03-01 February 15 - 18, 1994

The objectives of the run were to operate at full bed height with bed temperature of 1540 °F without sintering by adjusting total and secondary splitting air flow, and to test the newly installed 4 point sorbent injection system.

During the previous outage the fuel nozzle skateboards were moved eight inches toward the rear of the boiler wall to try to balance front to rear bed temperature distribution at higher splitting air flows. Also the start up bed zone liner on the north and south walls was removed and replaced with refractory because of distortion of the liner metal. The ceramic lined four point sorbent injection system was installed.

The gas turbine was rolled at 2218 hours, paralleled at 2233 hours and circulation through the combustor established at 2247 hours on February 16. The first step of the curing of the start up bed zone refractory was completed.

The bed preheater was ignited at 0725 hours on February 17th. Slow step changes were made in the windbox temperature increase for the start up bed zone refractory curing plan.

The steam turbine was rolled and paralleled at 1258 hours on February 17th. Coal fire was achieved at 1458 hours. Air flow was increased, freeboard mixing steam initiated, and sorbent injection started and #11 cyclone was spoiled.

Bed level was increased and once through boiler operation was achieved at 2043 hours on February 17th.

A leak was found on the sample line to the HGCU gas analysis cabinet. Plans were made to repair the leak with the unit in service. Bed level was held at 102 inches to allow the start up sand to be purged.

After further evaluating the leak on the HGCU sample line and the available means to repair the leak it was decided to shut the unit down, make the required repairs, and then start the unit back up.

The combustor was tripped manually at 1414 hours on February 18th. The bed ash reinjection vessels were filled with material from the bed in preparation for a hot restart.

The gas turbine was removed from service at 1544 hours on February 18th and a maintenance clearance placed on the combustor for repair of the HGCU sample line leak.

4. Start-Up TD-SU-94-03-02 February 18 - 25, 1994

Following the repairs to the HGCU sample line the gas turbine was rolled at 2100 hours, paralleled at 2110 hours and valves opened to the combustor at 2114 hours on February 18th.

Problems were experienced when trying to light the bed preheater until the light off oil pressure was increased. Oil fire was achieved at 2348 hours on February 18th. The steam turbine was rolled and paralleled at 0329 hours on February 19th. The north coal paste tank agitator motor bearing failed and the motor was replaced. After this motor replacement coal fire was established at 0612 hours on February 19th. Spoiling air was placed in service on #11 primary cyclone. Sorbent injection was placed in service at 0648 hours.

Once through boiler operation was achieved at 0846 hours. Bed level was increased, but stopped and held at 106 inches because of high temperatures on the APF outlet pipe metal. On February 21st Fiberfrax insulation was pumped into the hot spot areas. This insulation reduced the temperatures to acceptable levels.

At 2253 hours on February 22nd bed level was increased to 142 inches at 1540 °F bed temperature and 90% sulfur retention. Tempering air was used to limit APF temperatures to 1400 °F. Splitting air was increased in steps to 6000 pph and the secondary needle valves opened to 5.5 turns open (approximately 30% of the total flow). Later in the day #11 primary cyclone dip leg experienced secondary combustion. The temperatures were not extremely high because of the spoiling air. This secondary combustion could not be controlled by changing air flow as has been the case previously.

On February 23rd bed temperature was lowered to 1520 °F due to high cyclone inlet temperature on #16 primary cyclone and because of sintering in the bed.

While holding at the reduced bed temperature #4 paste pump tripped due to pluggage in the strainer. Bed level and temperature were lowered to stabilize bed conditions. The pump strainer was cleaned and the pump returned to service. Bed level was then lowered to 100 inches because of the evidence of sintering. While at this lower boiler flow condition the vertical separator bypass valve was closed to try to reduce the high tube temperatures in the evaporator section of the boiler.

On February 24th the vertical separator bypass was opened about 20% so that load could be increased without over pressurizing the vertical separator. Main steam temperature was lowered to 900 °F and the main steam attenuator was biased to force more feedwater through the evaporator and help reduce high temperatures in the evaporator tubes.

Bed level was then increased to 150 inches and bed temperature increased to 1520 °F (High cyclone inlet temperatures prohibited a higher bed temperature set point). Splitting air flow was decreased from 1000 pph to 750 pph on #1 and #6 fuel nozzles to lower the cyclone inlet temperatures on #12 and #16 primary cyclones. This change also helped bed temperature distribution somewhat but also increased sintering.

Early morning of February 25th #16 primary cyclone dipleg experienced secondary combustion. By raising air flow and lowering #1 fuel nozzle splitting air flow to 650 pph from 750 pph this secondary combustion was reduced.

At 1305 hours on February 25th the sorbent booster surged and tripped. The combustor was manually tripped by the operator at 1309 hours.

The bed material was cooled using the gas turbine and then the gas turbine was removed from service at 1425 hours on February 25th. The bed material was removed from the boiler, the combustor cooled and then released to maintenance for outage work.

5. Start-Up TD-SU-94-04-01 March 1 - 9, 1994

Once again the goal of the run was to achieve full bed height at 1540 °F bed temperature without sintering the bed.

The gas turbine was rolled at 1409 hours, paralleled at 1443 hours and the gas turbine valves opened at 1451 hours on March 2nd. A leak was found on the external piping of the primary ash system. The gas turbine was tripped at 1510 hours to repair the leak.

After the leak was repaired the gas turbine was rolled at 1832 hours, paralleled at 1846 hours and valves opened to the combustor at 1915 hours on March 2nd. The bed preheater was lit at 0147 hours on March 3rd. When vertical separator pressure started increasing the vertical pressure control valve stuck and then opened rapidly causing a high level in the vertical separator and a combustor trip at 0214 hours.

At 0252 hours the bed preheater was relit. The vertical separator pressure control valve was manually opened. The steam turbine was rolled and paralleled at 0757 hours on March 3rd.

Coal firing was attempted at 0913 hours but aborted when #2 and #4 paste pumps would not pump (the nozzles were plugged). All lines were reversed, clean blown and then blown out with nitrogen. A coal fire was then accomplished at 1022 hours on March 3rd.

Once through boiler operation occurred at 1641 hours on March 3rd. As was done on the last run, main steam temperature was set at 900 °F and the attemperator biased to force as much feedwater flow through the evaporator as was possible to help control high evaporator tube temperatures.

Bed level was held at 115 inches to allow time to purge the start up sand from the bed. At 2100 hours on March 4th bed level was raised to 142 inches with bed temperature at 1520 degrees. Splitting air flow was increased to 6000 pph. Sulfur retention was maintained at 90%. A performance test was conducted at these conditions on March 5th and 6th.

The HGCU backpulse compressor 4th stage rings failed on March 5th and the backup compressors were used while repairs were made.

At 0015 hours on March 7th bed level was raised to 150 inches with bed temperature at 1520 °F to evaluate the sulfur retention with a deeper bed. Splitting air flow was lowered to 800 pph from 1000 pph on #1 and #6 fuel nozzles with 5470 pph total flow to reduce the high cyclone inlet temperatures on #12 and #16 primary cyclones. A performance test was conducted at these conditions on March 7th.

On March 8th bed level was lowered to 142 inches, bed temperature raised to 1540 °F, splitting air flow lowered from 800 pph to 600 pph on #1 and #6 fuel nozzles and total splitting air flow lowered to 5200 pph to try to improve bed conditions for a performance test at 142 inches bed level and 1540 °F bed temperature. By 2330 hours all the signs confirmed that the bed was again sintered. Bed temperature was lowered to 1520 °F and bed material from the reinjection vessels was fed into the bed to help purge out the sinters. At 0600 hours on March 9th conditions had not improved and bed temperature was lowered to 1510 °F.

While trying to make a paste product with fewer fines to test the effect of the size distribution of the paste on sinter production, the paste pumpability drastically reduced due to incoming coal changing. At 1125 hours #6 paste pump plugged. While trying to unplug this pump to return it to service #4 paste pump plugged. The combustor was manually tripped at 1130 hours on March 9th due to the unstable bed conditions. The paste pumps were reversed and clean blown. All blew clean except for #4 fuel nozzle.

The bed ash reinjection vessels were filled from the bed (in anticipation of a hot restart), bed level was lowered to below the fuel nozzles and the gas turbine removed from service at 1643 hours on March 9th. The combustor was tagged out to maintenance for mechanical cleaning of #4 fuel nozzle. While the fuel nozzle cleaning was being completed the paste tank was emptied and cleaned.

6. Start-Up TD-SU-94-04-02 March 10, 1994

The gas turbine was rolled at 1409 hours, paralleled at 1429 hours and the valves opened to the combustor at 1457 hours on March 10th. An oil fire was established at 1617 hours.

The #12 and #16 primary cyclone suction nozzles and dipleg temperatures indicated that these cyclones were plugged. Pressure vessel pressure was increased to the maximum obtainable pressure in an attempt to blow out the plugs. This attempt was not successful. The combustor was tripped at 1829 hours on March 10th.

After cooling the bed material the gas turbine was removed from service at 1941 hours on March 10th. The bed material was removed and the combustor cooled for maintenance outage activities.

7. Start-Up TD-SU-94-05-01 March 15 - 23, 1994

The goal of the run was again to operate the unit at full bed height without sintering the bed.

The gas turbine was rolled at 2102 hours on March 15th. The gas turbine was tripped when a control fluid leak was found on one of the gas turbine air valves. This leak was repaired and the gas turbine rolled at 2234 hours, paralleled at 2050 hours and the valves opened to the combustor at 2254 hours on March 15th.

At 0448 hours on March 16th an oil fire was established with the bed preheater. While in the bed preheating mode a leak was found on the splitting air header pressure relief valve fitting. Plant air

was connected to each fuel nozzle splitting air line to provide purge air to the nozzles while the leak was repaired.

The steam turbine was rolled and paralleled at 1124 hours on March 16th. A coal fire was established at 1448 hours and once through boiler operation achieved at 1824 hours on March 16th.

On March 18th, after purging the start up sand from the bed, bed level was increased. With a bed temperature of 1520 °F 140 inches bed level was the highest load that was attainable. Air flow was at the maximum and the O₂ level was at the minimum. The heat transfer in the bed was very high. Bed level was lowered to 137 inches to give some margin on excess air for the weekend. During the early evening signs of sintering were seen at these conditions. High cyclone inlet temperature on #16 primary cyclone forced a bed temperature cut to 1510 °F during the night of March 18th.

On March 19th the performance of the fuel prep system crusher deteriorated forcing a load cut to 122 inches bed level and bed temperature of 1490 degrees. Following several minor mechanical changes the crusher throughput was increased enough to support full load but the left side gap would still not open up. This produced a paste product that was less than desirable. Bed sintering was evident from the time that the bed level was increased from 115 inches and for the remainder of the run.

At 1400 hours On March 21st splitting air flow was increased to 6000 pph to try to reduce the sinter production. At 0900 hours bed level was increased to 129 inches and bed temperature raised to 1520 °F to see if the change in splitting air flow had improved the situation.

Since more than 700 hours of coal fire had been logged on the APF at temperatures less than 1400 °F without any increase in the differential pressure across the filter, it was decided to allow these temperatures to increase up as high as 1450 °F. Tempering air to the APF was removed from service to allow this to happen and to increase the amount of fluidizing air through the bed to see if this would improve the sintering situation. It did not appear so.

On March 22nd the bed conditions had not improved and bed level was moved down and back up to try to shake out the sinters from the tube bundle. No significant improvement was seen. At 1245 hours bed level was then lowered to 113 inches and bed temperature dropped to 1480 °F and left overnight to allow the bed to purge of any sinters that had been shaken loose.

Overnight the APF head metal temperature had increased to 550 °F in one spot. Fiberfrax insulation was pumped into this hot spot and the temperature was reduced to approximately 350 °F.

On the morning of March 23rd bed conditions still did not seem to be much improved. At 1050 hours on March 23rd the gas turbine tripped on low lube oil pressure. During the outage the trip pressure switch was found to be faulty.

The bed was inerted with nitrogen and then cooled using gas circulation. All bed material was removed, the combustor was force cooled and then released to maintenance for outage work.

8. Start-Up TD-SU-94-06-01 Beginning March 30, 1994

The purpose of the run was to log at least 30 days operation for a reliability run, to conduct testing for hazardous air pollutants and to try to determine the threshold for sintering.

The gas turbine was rolled at 1456 hours, paralleled at 1522 hours and valves opened to the combustor at 1528 hours on March 30th. The gas turbine low pressure compressor was polished with Carboblast during the air warming period (the compressor had been liquid cleaned during the outage).

Oil fire was established at 2201 hours. A failed cooling coil on the auxiliary boiler steam sample contaminated the condensate cycle causing a delay in releasing the steam turbine for rolling. The steam turbine was rolled and paralleled at 0444 hours on March 31st.

Coal fire was initiated at 0908 hours on March 31st with 5 pumps. The #5 paste pump would not pump when it was ordered on. When the pump was cleaned the strainer was found to be plugged with dry coal.

Following coal fire problems were experienced with removing ash from the APF. The ash seemed to be hanging up in the cone at the bottom. Using the ash blow out air valves and the air cannon seemed to help.

A leak developed on the impulse line to the APF gas flow meter. This instrument was removed from service and the line plugged. The bed level was increased to 115 inches and held there to purge the start up sand from the bed.

The unit remains in service at the end of the quarter.

B. Maintenance

1. Outage TD-OT-94-01-01 January 11 - 14, 1994

All routine combustor inspections were completed.

Primary cyclone inspection yielded sinters, indicating that they had all had secondary combustion during the run.

Changed bag filters on precipitator ash removal bag house.

Installed two additional thermocouples on each primary cyclone dip leg to detect the existence of fires.

2. Outage TD-OT-94-02-01 January 29 - February 15, 1994

Repaired tube leaks in #56 evaporator bundle and wall tube caused by erosion from bed material channeling behind the warped start bed zone liner.

Moved the fuel nozzle skateboards approximately 8 inches toward the rear wall of the boiler.

Cleaned hard ash from bed bottom and bed bottom coolers (created by the water from the tube leak).

Inspected HGCU backpulse compressor.

Pumped insulation in HGCU expansion joint #7.

Added N-90 temperature indication and overtemperature trip on sorbent air heater.

Hard surface weld repaired sorbent drying mill hammers.

Rebuilt sorbent cyclone separator inlet duct.

Cleaned HGCU screw cooler and inspected drive end bearing and speed pickup.

Liquid cleaned gas turbine low pressure compressor.

Removed mechanical gear reducer from both sorbent injection rotary feeders and rebuilt the west feeder. Rebuilt cyclone ash fluidizing air blower.

Removed bed zone liner plate on north and south sides and replaced with refractory.

Rebuilt yard crusher #2.

Replace HCV-B817 and HCV-B818.

Installed new ceramic lined pipe for four point sorbent injection system.

Repaired 2.3 KV cable to CH-B transformer.

Cleaned top main turbine lube oil cooler and repaired leak in head.

3. Outage TD-OT-94-03-01 February 25 - March 1, 1994

Removed outer wing on #1 and #6 fuel nozzle skateboards.

Refurbished sorbent booster compressor inlet guide vane and repaired pressure ratio controls.

Rebuilt LCV-U200A (vertical separator drain valve).

Cleaned sorbent air cooler.

4. Outage TD-OT-94-04-01 March 10 - 15, 1994

Moved #6 fuel nozzle skateboard 8 inches toward front boiler wall and 7 inches to north.

Replaced HGCU screw cooler hydraulic drive motor.

5. Outage TD-OT-94-05-01 March 23 - 30, 1994

Machined fuel prep crusher rolls flat and then added grooves.

Modified chute from vibrating feeder CVF-1 to hopper T-1.

Replaced bearing on south screw of fuel prep crusher feed screw.

Replaced economizer outlet duct expansion joint.

Installed probes on APF dirty and clean gas sample locations for HAP testing.

Liquid cleaned gas turbine low pressure compressor.

Cleaned Graham vacuum pump seal water cooler.

Replaced conveyor belt on bed ash Flexowell belt.

Repaired O2 analyzer sample lines.

Installed air filter in HGCU pulse valve pilot solenoid air supply.

Replaced 4th stage rings in HGCU backpulse compressor.

V. MANPOWER REPORT

As of March 31, 1994, American Electric Power Service Corporation actual work-hours for the Phase III accounted for 39.3% of the total budget of 135,098. Figure 1 represents the budget versus actual work-hours for this phase.

Figure 1: Budget versus Actual

DATE

FILMED

7/7/94

END