SEMINOLE ELECTRIC COOPERATIVE INCORPORATED

(FOR INTEROFFICE USE)

TO: Mike Opalinski

DATE: February 3, 1988

FROM: Phil Bucci

SUBJECT: FGD BYPASS TEST - FINAL REPORT

Attached is the final report on bypass testing of Seminole Units 1 and 2 that occured during the fall of 1987.

This report was sent out in draft form during November 1987, for review and comment. Due to my extended absence during December it was not sent out in its final form.

If there are any questions, please let me know.

PB:MR

cc: J. Duren
A. Townsend
R. Lynes
M. Swiger
J. Welborn

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SU enO
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FGD BYPASS TESTING

INTRODUCTION

Seminole received permission, as required by Condition of Certification XVI, from the Department of Environmental Regulation to conduct a sixty day test, per unit, with a partial bypass of flue gas, to determine the effects on system operation.

Testing on Unit 1 was conducted on August 5 through October 3 and Unit 2, August 31 through October 15.

The purpose of testing was to determine:

the amount of flue gas that could be bypassed without exceeding sulfur dioxide emission limits.

if carryover from the FGD system could be reduced or eliminated with partial bypass.

if increased stack exit temperature due to bypass would increase plume buoyancy and improved dispersion.

if increased stack temperature would improved visibility by decreasing or eliminating the condensed vapor plume.

BYPASS TEST PROGRAM

The bypass testing was conducted in three phases to determine the most practical and cost effective method of bypass operation.

PHASE 1

With the unit at full load determine the maximum amount of bypass attainable while maintaining 90% SO2 removal efficiency. Hold the bypass damper in this position and vary the number of recycle pumps in service as load decreased, while continuing to meet required SO2 removal efficiency.

PHASE 2

Operate with four modules and four recycle pumps per module in service and increase or decrease the amount of flue gas bypassed as unit load varies while maintaining 90% SO2 removal efficiency.

PHASE 3

While operating with the maximum amount of bypass determined in phase 1 increase the dibasic acid concentration to determine the effect on removal efficiency and/or bypass quantity.

TEST RESULTS

PHASE 1 - UNIT 1

Phase 1 testing began on August 13 and continued through August 21. During this test approximately 5-6 percent of the total flue gas flow was bypassed. Flows were estimated using a weighted average calculation based on temperatures at the stack exit (138.5), stack inlet (130) and bypass (279.2). Temperatures for stack inlet and bypass were taken from the thermocouple readings and stack exit temperatures were measured during manual stack sampling.

Phase 1 was repeated toward to end of the test period (9/24 - 10-2) with the following results.

	Phase 1-1	Phase 1-2
Average MW	587	520
Average % Ro(Removal Effic.)	90.5%	90.7%
Average Bypass volume (ACFM)	100,224	99,247
Average Bypass %	5.7%	6.3%
Average DBA (GPM)	1.81	1.38
Number recycle pumps:		
500-600 MW	16	16
400-500 MW	15	16
300-400 MW	NA	12 (3 modules)

During both phase 1 test periods, the visible condensed moisture plume at the stack exit was decreased but the 8 degree F increase in stack temperature was insufficient to eliminate it.

Carryover of liquid droplets from the stack did not appear to be reduced during the test program, based on manual stack test results.

PHASE 2 - UNIT 1

Phase 2 of the Unit 1 bypass testing began on August 21 and continued through August 30. Testing was repeated on September 17 through September 23.

Phase 2 was designed to use the bypass control damper to regulate SO2 removal efficiency. Sustained high unit load during phase 2-1 testing did not allow significant bypass damper increase to occur; however, slightly lower load did occur during phase 2-2.

	Phase 2-1	Phase 2-2
Average MW	601	576
Average % Ro	90.4	90.7
Average bypass volume (ACFM)	70,529	98,717
Average bypass %	4.0	5.6
Average DBA (GPM)	1.44	1.40

As with phase 1, phase 2 bypass volumes were insufficient to eliminate the condensed vapor plume or affect FGD carryover.

PHASE 3 - UNIT 1

Phase 3 testing began on August 31 and continued through September 16. In phase 3 testing, concentrations of dibasic acid were increased from 800 - 900 PPM to 1200 - 1500 PPM to determine if there was any effect on removal efficiency (%Ro) or attainable bypass amounts.

	Phase 3
Average MW	572
Average % Ro	90.8
Average bypass volume (ACFM)	126,819
Average bypass %	7.2
Average DBA (GPM)	2.15

During phase 3 testing bypass amounts were consistently higher than phases 1 and 2 but did not appear to affect FGD performance.

Attachments 1,2 and 3 show the daily average system data, taken from FGD operators logs, that were used to assess bypass performance.

SO2/NOX CEM TESTING

On October 2, manual sampling was conducted in the stack to verify the SO2/NOX CEM data used to calculate removal efficiency during the bypass testing. Results indicate SO2 CEM readings to be low and NOx readings to be correct, during bypass open periods. SO2 conversion from PPM to lbs/mmbtu were also affected by low readings from the stack O2 monitor.

MANUAL STACK SAMPLING RESULTS

Following is a comparison of manual stack sampling data obtained during bypass open and bypass closed operation.

	Bypass Open	Bypass Closed
Moisture	12.94	13.90
Percent Excess Air	38.16	38.60
Velocity	28.40	25.84
ACFM	1,932,288	1,758,323

UNIT 2 BYPASS TEST

Unit 2 FGD bypass began August 31 and continued through October 15. Due to a significant difference in test results, September and October data are reported separately.

UNIT 2 - SEPTEMBER

During the month of September, Seminole Unit 2 bypass testing was conducted in phase 2. Four modules with four pumps per module in service, due to consistently high unit load.

This test provided the following results, based on daily high load, daily low load and monthly average load.

	HIGH	LOW	AVERAGE
MW	625	393	544
% Ro	90.1	90.8	90.5
Bypass Volume	217,751	287,794	254,161
Bypass Percent	12.4%	16.4%	14.4%
DBA(GPM)	.83	2.29	1.42

The highest bypass volume was attained on September 11, at a load of 428 mw. Calculated flue gas was 21.3% of total flow (374,041 ACFM).

Attachment 4 shows daily average data taken during September.

UNIT 2 - OCTOBER

Beginning on October 1 a substantial decrease in bypass volume was recorded based on stack temperature and continued through the remainder of the test period. These bypass volumes do not agree with the results of manual stack tests conducted on October 1 and 12. Following is a comparison of test results for October 1 and 12.

	LOG	MANUAL
October 1		
Bypass temperature	299	299
Stack temperature	133	149
FGD temperature	123	123
Calc. volume	100,093	259,890
Bypass percent	5.7%	14.8%
October 12		
Bypass temperature	287	287
Stack temperature	122	131
FGD temperature	123	123
Calc. volume	0	86,045
Bypass percent	0	4.9%

Beginning on October 10 through October 15, during periods when the load was below 400 MW. Operators were able to remove a module from service. Results of this test will not be discussed due to lack of bypass data, but may be found in attachment 5.

PROBLEMS DURING TESTING

The most significant problem experienced during bypass testing of Units 1 and 2 was the inability to adequately determine the amount of flue gas being bypassed.

Representative's of the damper manufactures calculated a curve for the Seminole bypass control damper indicating 15% bypass would be 38 degrees open on the damper or 243,048 ACFM.

During manual stack testing conducted on October 1 the following data was collected at 650 MW.

	Control Room Log	Manual Stack Testing
Stack inlet temperature	313	313
Stack exit temperature	133	149
FGD oulet temperature	123	123
Volume of bypass (ACFM)	93,069	240,574
% bypass calculated	5.3%	13.7%

On October 12 the tests were again conducted at 640 MW with the following results.

	Control Room Log	Manual Stack Testing
Stack inlet temperature	298	298
Stack outlet temperature	122	131
FGD outlet temperature	123	123
Volume of bypass (ACFM)	0	81,332
% bypass calculated	0	4.6%

POTENTIAL PROBLEMS WITH CONTINUED BYPASS

Two potential problems may be encountered in the event of continued bypass.

1. Stack Lean -

   Prior the beginning of bypass testing on Units 1 and 2 stack lean measurements were taken daily at the 460' level. Previous experience gathered at other utilities, EPA studies, and EPRI reports suggested that when bypassed gases were mixed in the stack liner a substantial amount of thermal expansion at the point of the wet - dry interface could be expected. No movement of the stack liners was detected, possibly due to the small amounts of gas being bypassed.

2. Opacity -

   During the bypass testing visual and photographic records of the exit plume were taken periodically in the morning, noon and afternoon.

   Results of these observations appear to indicate that the saturated moisture plume density and the formation of a secondary plume at the stack exit is influenced by stack exit temperature and ambient meterological conditions. Periods of moderate temperature (83 degrees F) and relative humidity (75%) result in dissipation of the condensed moisture plume and formation of a secondary plume with an opacity in excess of 50%; however, higher ambient temperature (96 degrees F) and lower relative humidity (53%) result in no condensed moisture plume and no exit opacity. During both periods both units were at full load and stack exit temperatures were 147 degrees F.

Recently EPA Region IV, has developed a concern over opacity from coal fired units with wet flue gas desulfuriaztion systems. Seminole Unit 2 is one of the plants of concern due to our request for an alternate opacity limit of more than 20%. Seminole has not had a problem with regulatory agencies in the past because a valid visual mesurement (40 CFR 60, Appendix A, Reference Method 9) could not be taken due to the condensed moisture plume at the stack exit. If bypassing is continued and the condensed vapor plume is eliminated any opacity in excess of 20% that may be read at the individual stack exits will be subject to enforcement action from either federal or state regulatory agencies.

UNIT 1 RAW DATA
PHASE 1 TESTING

PHASE 1-1 (DAILY AVERAGE)

Date	MW	% Ro	Bypass Volume	Bypass %	DBA GPD	Modules/Punps ( )=hours
8/13	591	90.6	50,991	2.9	2400	4/16(12)-4/15(12)
8/14	575	90.9	75,608	4.3	1500	4/16
8/15	578	90.7	87,916	5.0	1800	4/16(17)-4/15(7)
8/16	558	90.0	96,708	5.5	2400	4/16(15)-4/15(9)
8/17	561	90.0	103,741	5.9	1200	4/16
8/18	619	89.6	131,874	7.5	5200	4/16
8/19	603	90.6	77,366	4.4	2400	4/16
8/20	598	91.0	152,974	8.7	5700	4/16(17)-4/15(7)
8/21	601	90.0	119,566	6.8	900	4/16

PHASE 1-2

9/24	518	90.8	94,950	5.4	3000	4/16(18)-3/12(6)
9/25	542	90.8	114,291	6.5	2400	4/16
9/26	527	90.6	93,190	5.3	1800	4/16(10)-3/12(5)
9.27	522	90.0	101,983	5.8	2700	4/16(18)-3/12(6)
9/28	544	90.5	109,016	6.2	900	4/16(19)-3/12(5)
9/29	533	91.5	96,708	5.5	2100	4/16(18)-3/12(6)
9/30	528	90.5	130,116	7.4	1800	4/16(18)-3/12(6)
10/1	473	90.6	133,633	7.6	2700	4/16(15)-3/12(9)
10-2	490	90.2	128,358	7.3	600	4/16(7)-3/12(5)

ATTACHMENT 1

Unit 1 Raw Data
Phase 3

DATE	MW	% Ro	BYPASS VOLUME	BYPASS PERCENT	DBA GPD	( )=hours MODULES/PUMPS
8/31	600	90.6	87,916	5.0	2400	4/16(8)4/15(16)
9/1	599	91.1	91,433	5.2	1200	4/16(8)4/15(16)
9/2	566	90.8	137,149	7.8	4200	4/16
9/3	NO DATA					
9/4	551	90.8	114,291	6.5	3900	4/16
9/5	560	90.5	131,874	7.5	4200	4/16
9/6	555	90.8	135,391	7.7	3600	4/16
9/7	517	90.7	172,316	9.8	3600	4/16
9/8	595	91.0	152,974	8.7	5100	4/16
9/9	602	91.6	107,258	6.1	2400	4/16
9/10	610	91.2	117,808	6.7	1200	4/16
9/11	613	90.5	105,499	6.0	2700	4/16
9/12	564	90.5	119,566	6.8	2700	4/16
9/13	527	91.0	144,182	8.2	3600	4/16(16)4/15(8)
9/14	556	90.3	158,249	9.0	2700	4/16
9/15	570	90.4	137,149	7.8	3300	4/16
9/16	567	90.4	116,049	6.6	2700	4/16

ATTACHMENT 2

UNIT 1 - RAW DATA

PHASE 2 TESTING

4-MODULES-16-PUMPS

Phase 2-1

Date	MW	% Ro	Bypass Volume	Bypass Percent	DBA GPD
8/22	596	90.4	109,016	6.2	1200
8/23	563	90.5	75,608	4.3	1200
8/24	593	90.2	66,816	3.8	900
8/25	603	90.8	43,967	2.5	1500
8/26	642	90.3	49,233	2.8	3000
8/27	627	90.5	47,475	2.7	2100
8/28	584	90.4	77,366	4.4	3300
8/29	605	90.3	65,058	3.7	2700
8/30	592	90.4	100,224	5.7	2700

Phase 2-2

Date	MW	% Ro	Bypass Volume	Bypass Percent	DBA GPD
9/17	586	90.5	107,258	6.1	1200
9/18	591	90.6	58,025	3.3	900
9/19	580	90.7	58,025	3.3	3000
9/20	579	90.9	130,116	7.4	1500
9/21	570	90.8	117,808	6.7	1500
9/22	573	90.8	98,466	5.6	3300
9/23	554	90.8	121,324	6.9	2700

ATTACHMENT 3

DATE	MW	%Ro	BYPASS VOLUME	BYPASS PERCENT	DBA GPD
9/1	625	90.1	217,751	12.4	1200
9/2	559	90.0	275,701	15.7	3900
9/3	519	90.6	284,482	16.2	3000
9/4	553	90.7	275,701	15.7	2700
9/5	562	90.8	272,190	15.5	3300
9/6	554	90.3	275,701	15.7	3000
9/7	493	90.4	291,506	16.6	2400
9/8	579	90.5	286,238	16.3	2700
9/9	588	90.3	279,214	15.90	3000
9/10	537	90.7	282,726	16.1	2700
9/11	428	90.6	374,041	21.3	2700
9/12	393	90.8	287,994	16.4	3300
9/13	524	90.7	284,482	16.2	2700
9/14	557	90.7	303,799	17.3	1500
9/15	590	90.6	298,531	17.0	2400
9/16	563	90.5	312,579	17.8	1800
9/17	593	90.4	280,970	16.0	300
9/18	589	90.4	275,702	15.7	600
9/19	587	90.4	266,922	15.2	1200
9/20	574	90.6	259,899	14.8	2100
9/21	575	90.8	247,605	14.1	2100
9/22	570	90.4	265,166	15.1	1500
9/23	554	90.4	251,117	14.3	1500
9/24	545	90.3	235,312	13.4	2100
9/25	546	90.6	228,228	13.0	2100
9/26	529	90.4	189,655	10.8	1500
9/27	536	90.4	117,656	6.7	1200
9/28	545	90.5	136,986	7.8	900
9/29	454	90.7	138,714	7.9	2100
9/30	529	90.9	128,204	7.3	1800

ATTACHMENT 4

UNIT 2 DATA

OCTOBER

DATE	MW	%Ro	BYPASS VOLUME	BYPASS PERCENT	DBA GPD	MODULES/PUMPS ( )=hours
10/1	553	90.2	89,568	5.1	1500	4/16(20)-3/12(4)
10/2	477	90.4	84,299	4.8	1500	4/16
10/3	488	90.5	63,224	3.6	2100	4/16
10/4	447	90.5	33,369	1.9	1800	4/16
10/5	480	90.5	5,268	.30	1200	4/16
10/6	439	90.2	8,780	.50	1200	4/16
10/7	416	90.5	15,804	.90	1500	4/16
10/8	448	90.6	17,560	1.0	1800	4/16
10/9	456	90.4	31,608	1.8	2400	4/16
10/10	451	90.3	33,364	1.9	1800	4/16(17)-3/12(7)
10/11	442	90.7	33,364	1.9	1800	4/16(18)-3/12(6)
10/12	513	90.8	0	0	1800	4/16(20)-4/14(4)
10/13	362	91.1	0	0	1500	4/16
10/14	531	90.3	0	0	1800	4/16(17)-3/12(7)
10/15	421	90.7	0	0	300	4/16(20)-3/12(4)

ATTACHMENT 5

PEABODY PROCESS SYSTEMS

FLUE GAS DESULFURIZATION SYSTEM

FINAL PERFORMANCE TEST REPORT

SEMINOLE ELECTRIC COOPERATIVE, INC.

PALATKA, FLORIDA POWER STATION

Prepared by,

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January 8, 1986

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I. INTRODUCTION

Final perfomance tests at the primary (86%) and secondary (90%) SO_2 removal conditions were performed on Seminole Electric Cooperative's (SECI) Unit 2 flue gas desulfurization (FGD) system on November 12 and 13, 1985. In addition, two pump operation at the primary and secondary conditions was demonstrated on November 14 and 15. The consumption of the organic acid, DBA, was measured in tests on November 17 to 24.

Several independent testers were involved in the test work and the results of their efforts are detailed in the attached reports:

Radian Corporation - Final Performance Test Results

Environmental Science and Engineering, Inc (ES&E)-
Performance Guarantee Test Report

Detailed results of power measurements

ES&E's report contains the calculations and results for daily sulfur dioxide measurements at the FGD inlet and stack, measurement of particulate concentrations at the FGD inlet and stack on November 12, and daily gas volume and pressure drop data.

The Radian report contains the bulk of the performance test calculations and results including DBA concentrations, limestone consumption, DBA degradation, and waste slurry flow.

The power measurements were performed by SECI, PPSI, and Miller Electric.

The following personnel were on site during the performance tests:

PPSI	SECI
Dennis Laslo	Richard Micko
Mark Valenti*	John Hurley*
Robert Boyle*	Mike Spezieli*
Nadia George*	Phil Bucci*

* part time

Radian	ES&E
A. F. Jones**	Vernon McKnight**

**Numerous testing personnel were on site, therefore, only the supervisor is mentioned.

II SUMMARY

The following is a summary of results of guaranteed items:

TEST	PRIMARY	SECONDARY
Date	11/13	11/12
FGD System Gas Flow, (MM lb/hr)	6.61	6.62
Guaranteed SO_2 Removal, Efficiency, (%)	86	90
Measured SO_2 Removal, Efficiency, (%)	89	90
Guaranteed Draft Loss, (In. W.G.)	5.6	5.6
Measured Draft Loss (In. W.G.)	3.8	4.1
Guaranteed Limestone Consumption, (TPH)	22.1	23.1
Measured Limestone Consumption, (TPH)	16.3	21.1
Guaranteed Power Consumption, (KW)	3,337	4,091
Measured Power Consumption, (KW)	3,296	4,071
[illegible]lowable Emissions (lb/MMBTU)	.0300	.0300
Measure[illegible]ate Inlet, (lb/MMBTU)	.0209	.0124
Measured Particulate Stack, (lb/MMBTU)	.0197	.0248
Guaranteed Waste Sludge Flow Rate, (lb/hr)	912,814	914,849
Measured Waste Sludge Flow Rate, (lb/hr)	633,000	716,000
Chloride Concentration, (ppm)	19,800	19,000

From the above summary and the demonstration of savings when using DBA (see section III-G, DBA Consumption and Economics), it can be concluded that the FGD system has passed all of the performance guarantees.

III RESULTS

A. SO_2 Removal Efficiency

Although Unit 2 is rated at 620 MW, the Unit was operated at 480 MW in order to provide design gas flow to the FGD system. Initially, SO_2 removal efficiencies were to be obtained utilizing the LSI SO_2 monitors. However, a check on the analyzer accuracy prior to the performance tests indicated the inlet monitors were reading incorrectly (low) and ES&E was contracted to perform Method 6 tests at the FGD inlet and stack. ES&E performed hourly readings throughout the 8 hour test.

DBA concentrations and pH were monitored hourly by Radian during the test.

SUMMARY OF RESULTS

Date	11/12	11/13
[illegible] flow, (MM lb/hr)	6.61	6.[illegible]
Dry Wt % Sulfur in coal	2.92	3.06
Average Gross MW	483	492
Average pH	5.31	5.55
Average DBA, (ppm)	360	447
Average SO_2 Removal, (%)	90	89
Average Stack SO_2 Conc., (lb/MMBTU)	0.4783	0.5202

As shown, the flue gas flows are within the specified range and the FGD system met performance guarantees on SO_2 removal efficiencies.

B. Limestone Consumption

Limestone consumption was measured by taking hourly tank-drop readings on the reagent storage tank, hourly density readings from the reagent pump, and daily limestone purity samples. At a constant pH, limestone consumption is linear with the sulfur removal and is thus affected by load, sulfur dioxide removal, and sulfur in the coal. The following is a summary of the limestone consumption tests:

SUMMARY OF RESULTS

Date	11/12	11/13
Limestone useage, (TPH)	21.1	16.5
Limestone purity, wt% $CaCO_3$	98.9	99.3
Average reagent, % solids	24.6	28.0
Average $\%SO_2$ removal	90.0	89.0
Dry %S in coal	2.92	3.06

C. Draft Loss

Pressure drop was initially measured by taking static pressure readings using a Type S pitot tube at the FGD inlet and the stack breaching. Interferences from the stack draft and gas turbulence at the stack breaching prevented obtaining an accurate reading. The outlet pressure was instead obtained from an upstream port after mutual agreement between PPSI and SECI. Measured readings agreed with the FGD control room panel readings. Altitude corrections were not applied to the readings (which would reduce pressure drop slightly).

SUMMARY OF RESULTS

Date	11/12	11/13
Inlet Gas Flow, (MM lb/hr)	6.61	6.62
Static pressure drop, (In. W.C.)	4.1	3.8

D. Particulate Emissions

Particulate emissions were measured utilizing EPA Method 17 at the inlet and Method 5B at the stack. ES&E measured the stack particulate on 11/12 and SECI measured it on 11/13. ES&E measured the inlet particulate each day (SECI sub-contract)

SUMMARY OF RESULTS

Date	11/12	11/13
Inlet concentration, (lb/MMBTU)	.0124	.0209
Outlet concentration, ([illegible])	.0248	.0197

E. Power Consumption

Unit No. 2 Power Consumption Tests were scheduled for November 12, 13 & 14, 1985.

The total FGD System power consumption was measured by recording the input (KW) power at the 6.9 KV switchgear in the main plant switchgear room - FGD feeders. Power data (three phase amps, phase volts, power factor and MW) preceded by the date and time were recorded using a recording watt-hour meter (Dranetz-Series 808 Electric Power/Demand Analyzer) and averaged over an eight hour period.

Power consumption not associated with the FGD System was measured by a clamp on ammeter and a calibrated voltmeter twice a day, then averaged and deducted from the total power consumption.

Power consumption for Ball Mill motor and Ball Mill miscellaneous pump motors were measured by panel ammeter, calibrated voltmeter and clamp-on ammeter respectively. To include the ball mill power consumption in the total FGD power consumption, measurements were taken once after testing hours and 25% of the total Ball Mill power consumption was added to the total power consumption. Absorber Recycle Pump motors' power were measured twice a day. The first reading on the first day was measured by a calibrated three phase ammeter, a calibrated three phase voltmeter and the panel ammeter and voltmeter. Later, panel ammeter readings and calibrated three phase voltmeter readings were used.

SUMMARY OF RESULTS

Total power with 4 pump operation, (KW)	4,071.3
Total power with 3 pump operation, (KW)	3,296.2
Total power with 2 pump operation, (KW)	2,431.1
Average measured pump power, (KW)	185.5
Average pump power obtained by subtracting total power for 3 and 2 pump operation, (KW)	216.3

F. Coal Analysis

Coal consumption was provided daily by SECI and a coal sample was also provided daily by SECI. The sample was split and sent for analysis by Radian and SECI. The results received from Radian are as follows:

As Received, Ultimate Analysis

Date	11/12	11/13
C	70.10	67.40
H	4.80	4.62
O	7.49	7.40
N	1.39	1.36
S (WET)	2.68	2.75
S (DRY)	2.92	3.06
Cl	0.21*	0.19
Ash	6.83	8.03
Moisture	6.70	8.44
Coal Feed Rate in TPH	201	192
HHV, BTU/LB	13,904	13,648

* obtained from SECI analysis (not Radian)

G. DBA Consumption and Economics

The DBA concentrations in the modules was constantly monitored during the two week tests. In addition, a 7-day test was performed in which the DBA addition and DBA losses were carefully monitored. The addition rate is the most accurate since it involves only measuring DBA tank drop. The loss rate is more difficult given the uncertainties in the emergency pond useage, stack carryover, and physical volume of the system. The loss rate measured by Radian was extremely high (pilot plant tests indicated losses 1/5 of those measured by Radian), probably due to the uncertainties mentioned, especially exchange of process water between the FGD dewatering system and the emergency pond.

However, even at these high loss rates, the economics are favorable as will be outlined below.

Results of 7-day DBA consumption test
(Reference Radian Report - page 7,8)

Pounds/hour required to maintain 1100 ppm	322
Theoretical loss in the cake	30.5
Average MW	508
Av[illegible] Removal	87.9
Average inlet SO_2 ppm	1,800

The "F" factors tabulated in PPSL-563 (10/1/85) do not include correction factors for L/G and pH. Since Unit 2 was run at gas volumes exceeding the values used in derivation of the "F" factor, the result is inaccurate and cannot be used to accurately correct DBA concentrations. Therefore, the economics were performed two ways - one utilizing the "F" factor, and the more accurate method of utilizing actual data.

"F" factor method:

F(20,000 ppm, 88% removal) = 1.3

correcting the gross MW for gas flow we get

$$MW = 508/480 \times 625 = 661$$

and the DBA consumption is

$$Q_{De} = (322/1.3) \times (338/661) = 126 \text{ lb/hr}$$

and

DBA \$/hr = 126 x \$0.20/lb = \$25/hr

Actual data:

The measured DBA consumption (Radian, page 10, Table 10) at full load (86%, 3 pumps) was 40 lb/hr or:

$/hr = 40 x $0.20/lb = $8.00/hr

correcting this to 338 MW average annual load:

DBA $/hr = 338/625 x $8.00 = $4.32/hr

Using the measured electrical consumption, the cost of operating four extra pumps is:

Cost $/hr (4 pumps) = 4 x 185kw x $0.035875 = $26.55/hr

Or in summary:

	Using Actual data	Using "F" Factor
Cost of DBA	$ 4.32/hr	$25.00/hr
Cost of extra pumping power	26.55	26.55
Savings with DBA	$22.23/hr	$ 1.55/hr
Annual savings (8760 hrs/yr)	$194,700	$13,600

The $194,700 figure is accurate since the tests were run very close to the "real life" assumptions in the September economic analysis. The DBA is not only less costly than pump power, it also allows operation at higher than design gas flows. Without DBA, operation at 650 MW would not be possible at the current full load gas flows, especially with the high sulfur coal currently used.

B. Waste Slurry

Waste slurry flow was measured by utilizing ultrasonic flow meters on the two operating pumps and by taking hourly density readings on a sample obtained at the pump discharge (at CSI). Results are summarized as follows:

Date	11/12	11/13
Waste Slurry, (lb/min)	11,932	11,050
Waste Slurry, (lb/min)	716,000	633,000
Average Density, (wt%)	3.2	3.6

I. Two Pump Operation

The FGD system was run with two pumps on November 14 and 15. SO_2 removal was increased by spiking with DBA until the target SO_2 removal was obtained (target SO_2 removals and measured SO_2 removals are not identical since SO_2 removal was estimated using the LSI monitors but results reported are always ES&E measured data). The results of two-pump operation is summarized in the following table with the three-, and four-pump results also provided for reference.

TWO, THREE, FOUR PUMP OPERATION-SUMMARY OF RESULTS

Test: / Date:	4 PUMPS 11/12	3 PUMPS 11/13	2 PUMPS 11/14	2 PUMPS 11/15
Target $\%SO_2$ Removal	90.0	86.0	86.0	90.0
Measured $\%SO_2$ Removal	89.8	89.0	85.0	88.5
%S in Coal	2.92	3.06	3.05	4.41
Ave. coal consumption, (TPH)	201	192	185	198
Ave. load, (MW)	483	492	477	489
FGD inlet gas flow (MM lb/hr)	6.62	6.61	6.08	6.22
Measured DBA conc., (ppm)	360	[illegible]	1,030	1,380
Reagent consumption, (TPH)	21.1	16.5	16.7	21.1
Reagent purity, $\%CaCO_3$	98.9	97.8	97.8	99.3
Power consumption, (MW)	4.07	3.29	2.43	----
Pressure Drop, (In. W.C.)	4.1	3.8	3.0	3.3
Particulate inlet, (lb/MMBTU)	.0124	.0209	.0232	.0134
Particulate stack, (lb/MMBTU)	.0248	.0197	.0250	.0200
Target process pH	5.50	5.50	5.50	5.50
Measured process pH	5.31	5.55	5.35	5.20

The total power drop from three pumps to two pumps indicates approximately 216 KW/pump while the measured pump KW is 185 KW/pump. The reason for the difference is unknown. The last two pump test was probably short on efficiency due to low pH and high %S in the coal, however, during the test, the efficiency estimated using the LSI monitors was 90%. A higher pH or a few hundred extra ppm of DBA would have easily met the 90% removal.