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High SO₂ Removal Efficiency Testing

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Quarterly Status Report - July - September 1994

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INTRODUCTION

This document provides a discussion of the technical progress on DOE/PETC project number DE-AC22-92PC91338, "High Efficiency SO₂ Removal Testing", for the time period 1 July through 30 September 1994. The project involves testing at six full-scale utility flue gas desulfurization (FGD) systems, to evaluate low capital cost upgrades that may allow these systems to achieve up to 98% SO₂ removal efficiency. The upgrades evaluated mostly involve using additives in the FGD systems. The "base" project involved testing at the Tampa Electric Company Big Bend station. All five potential options to the base program have been exercised by DOE, involving testing at the Hoosier Energy Merom Station (Option I), the Southwestern Electric Power Company Pirkey Station (Option II), the PSI Energy Gibson Station (Option III), the Duquesne Light Elrama Station (Option IV), and the New York State Electric and Gas Company Kintigh Station (Option V). By the end of September 1994, testing was completed for the base project and for all options.

The remainder of this document is divided into four sections. Section 2, Project Summary, provides a brief overview of the status of technical efforts on this project. Section 3, Results, summarizes the outcome from these technical efforts during the quarter. In Section 4, Plans for the Next Reporting Period, an overview is provided of the technical efforts that are anticipated for the fourth quarter of calendar year 1994. Section 5 contains a brief acknowledgment.

2.0

PROJECT SUMMARY

On the base program, testing was completed at the Tampa Electric Big Bend Station in November, 1992. The upgrade option tested was DBA additive. Project efforts during the third quarter of calendar year 1994 consisted of project management and technical transfer activities. The most significant technical transfer activity was a high-efficiency SO₂ removal workshop for U.S. utility and industrial representatives. The workshop was held in Pittsburgh in late September. Also in late September, a paper summarizing results from this project was presented at a DOE-sponsored U.S.-Japan joint technical meeting in Albuquerque, New Mexico.

For Option I, at the Hoosier Energy Merom Station, results from another program co-funded by the Electric Power Research Institute (EPRI) and the National Rural Electric Cooperative Association have been combined with results from DOE-funded testing. Three upgrade options have been tested: DBA additive, sodium formate additive, and high pH set point operation. All testing was completed by November, 1992. Project efforts during the current quarter primarily involved reporting.

Option II involved testing at the Southwestern Electric Power Company Pirkey Station. Baseline testing was conducted in February of 1993. Both sodium formate and DBA additives were tested as potential upgrade options. Parametric testing was conducted with DBA additive in March 1993 and with sodium formate in April 1993. Based on results from these tests, DBA appeared to be the more attractive upgrade option for this site, and a DBA additive consumption test was conducted in May 1993. There were only reporting activities for this site during the current quarter.

On Option III, for testing at the PSI Energy Gibson Station, baseline testing was conducted in May of 1993. Parametric testing with sodium formate additive began in September 1993 and was completed with a sodium formate consumption test in early October 1993. A DBA

additive performance and consumption test was conducted in late February through mid-March of 1994. Efforts during the current quarter included only data reduction and reporting.

Option IV is for testing at the Duquesne Light Elrama Station. The FGD system employs magnesium-enhanced lime reagent and venturi absorber modules. Baseline testing was completed in July 1993. An EPRI-funded model evaluation of potential upgrade options for this FGD system, along with a preliminary economic evaluation, determined that there were two attractive upgrade options for this site. One was to increase thiosulfate ion concentrations in the FGD system liquor to lower oxidation percentages and increase liquid-phase sulfite alkalinity. The other was to increase the venturi absorber pressure drop to improve gas/liquid contacting. Parametric testing of these upgrade options was conducted in late March of 1994. As for Option III above, efforts during the current quarter included only data reduction and reporting.

Option V is for testing at the New York State Electric and Gas Company Kintigh Station. Baseline testing was conducted in July 1994. Results from this testing are presented in this quarterly Technical Progress Report. Parametric testing at this site was conducted in late August, and a sodium formate additive consumption test was conducted in the first half of September 1994. Results from this parametric and additive consumption testing will be included in the next quarterly Technical Progress Report.

3.0

RESULTS

Results from the base program (at the Tampa Electric Big Bend Station) and the first optional site (Hoosier Energy Merom Station) were presented in detail in the April 1993 quarterly Technical Progress Report, and updates were included in the July 1993 and October 1993 reports. For the second optional site (the Southwestern Electric Power Company Pirkey Station), results were presented in the July 1993 quarterly Technical Progress Report and updated in the October 1993 report. There are no plans to discuss these three sites any further in this or future quarterly reports.

For the third optional site (the PSI Energy Gibson Station), baseline testing was conducted in May 1993, and those results were presented in the July 1993 quarterly report. Parametric testing at this site was completed in early October of 1993, and these results were discussed in the January 1994 Technical Progress Report. A DBA performance and consumption test was conducted in February and March of 1994. Preliminary results from this test were discussed in the April 1994 Technical Progress Report. An update of the results from this site will be presented after the revised draft Technical Note for this site is submitted, which will most likely be early in the first quarter of calendar year 1995.

Baseline testing at the fourth optional site (Duquesne Light's Elrama Station) was completed in July 1993. Those results were discussed in the October 1993 quarterly report. The results of EPRI-funded FGDPRIISM modeling and preliminary economic evaluations of potential upgrades for this FGD system were discussed in the January 1994 Technical Progress Report. In March of 1994, parametric testing of the most promising upgrade options was conducted. The preliminary results of these tests were discussed in the April 1994 Technical Progress Report. As for the Gibson site above, an update of the results from this site will be presented after the draft Technical Note for this site is submitted, which for this site will most likely be in the fourth quarter of calendar year 1994.

For the fifth optional site (the New York State Electric and Gas Company's Kintigh Station), baseline, parametric, and additive consumption efforts were completed during the current quarter. Results from the baseline testing at this site, which was conducted the week of 18 July 1994, are discussed below. The parametric and additive consumption tests at this site were completed late in the third quarter, and these results have not been adequately reviewed by the host utility, so these results will be included in the next quarterly Technical Progress Report.

3.1 Baseline Testing at the NYSEG Kintigh Station

The objectives of the baseline tests were to characterize FGD system performance at normal operating conditions without organic acid additive and to obtain process data suitable for calibrating EPRI's Flue Gas Desulfurization Process Integration and Simulation Model (FGDPRISM) to the Kintigh FGD system. The test approach and chronology are described in Section 3.1.1, and results are presented in Section 3.1.2.

3.1.1 Test Approach and Conditions

The NYSEG Kintigh Station is located in Niagara County near Barker, New York. Figure 1 is a simplified flow diagram for the Kintigh FGD system. Flue gas exits the boiler and passes through ESPs for particulate control. From the ESPs, flue gas goes through ID fans and then to the FGD system. At full load, four modules (with two additional spare modules) are required to treat flue gas from 685 MW of generating capacity.

The absorber modules are Peabody open spray towers. In this configuration, flue gas enters the bottom of the vessel and flows upward. A recirculating slurry is introduced countercurrent to the gas flow through up to five levels of spray headers. Each spray header level on the absorber has its own recycle pump. The combined L/G is about 116 gal/1000 acf, with all five headers in service and four modules in service at the full-load flue gas flow rate. Only four

Figure 1. Flow Diagram of New York State Electric and Gas Kintigh Station's FGD System

headers are typically required to achieve SO₂ emissions compliance (0.6 lb SO₂/million Btu), which is equivalent to about 85% overall SO₂ removal.

After leaving the spray section, the flue gas flows past a sieve tray to a vertical gas flow mist eliminator. From the mist eliminator, flue gas exits the absorber. The absorber exit gas then flows to the stack. The FGD system is equipped with an absorber bypass duct, but typically nearly all of the flue gas exiting the boiler is treated in the absorbers, and the stack operates in a "wet" mode.

The reagent used in the FGD system is a slurry of finely ground limestone. The limestone is ground in ball mills, and the prepared slurry is stored in a slurry feed tank, from which it is added to the absorbers at a rate to maintain the recirculating slurry pH set point. Elemental sulfur emulsion is added to the slurry feed tank to produce thiosulfate ion in the absorber reaction tanks, to serve as an oxidation inhibitor.

The recirculating slurry falls from the absorber into a secondary reaction tank external to the tower. In the secondary reaction tank, fresh limestone slurry is added to control the recirculating slurry pH set point. Slurry from the secondary reaction tank then flows by gravity to the primary reaction tank, which is integral to the bottom of the absorber. The slurry recirculation pumps draw suction from the primary reaction tanks.

Slurry from the primary reaction tank is also recirculated to hydroclones. A portion of the low solids content overflow from the hydroclones is used to wash the underside of the sieve tray below the mist eliminators. The remainder is routed to a baffled section in the primary reaction tank in the base of the absorber, from which it overflows to a waste sump along with a portion of the slurry from the primary reaction tank. The high-solids-content underflow from the hydroclones falls into the external, secondary reaction tank.

Waste slurry is bled from the primary reaction tank on each absorber to a waste slurry sump, where it is combined with the excess hydroclone overflow, a small bleed stream from the secondary reaction tanks, and some recycled thickener overflow. This mixed waste stream is fed to one of two thickeners. Liquor overflow from the thickeners flows to a supernate tank, and the underflow is fed to vacuum filters. The filtrate from the vacuum filters is returned to the thickeners. Supernate is returned to the absorber by being used in the limestone grinding circuit and by makeup to the secondary reaction tanks. A portion of the supernate is used to dilute the thickener feed stream. The primary makeup of fresh water to the FGD system is via the mist eliminator wash and pump seals.

The dewatered FGD sludge is blended with lime and fly ash from the ESPs for stabilization before being landfilled on the site. The solids content of the dewatered FGD sludge is approximately 65 wt%.

The baseline tests were conducted on a single module (Module E) of the FGD system. The four operating modules receive flue gas from a common plenum so that the flow to the test module could not be independently controlled. The flue gas flow to the test module varied slightly depending on the number of operating pumps and also varied with system load. However, a constant high load was maintained during most of the tests. During a typical test, one or more outlet flue gas SO_2 and velocity traverses were done while slurry and filtered slurry samples were obtained concurrently. During the two-day tests, slurry settling tests were also done. Process data were either logged automatically by the plant data acquisition system or recorded from local indicators as required.

The baseline test sequence (as it was actually carried out) is summarized in Table 1. The test series began with a two-day test at normal operating conditions (four modules on line, pH setpoint at 5.6, and four spray pumps operating per module). On the first test day, the SO_2 concentration in the module inlet duct was measured to evaluate the accuracy of the on-line

Table 1

Actual Baseline Test Conditions at Kintigh Station

Date	Test	Objective	Performance Indicators	pH	No. of Surry Pumps in Service	Flue Gas Velocity
7/18-7/19	1	Characterize baseline performance under normal operating conditions	SO ₂ removal Utilization Oxidation Solids dewatering Relative sat.	Normal 5.6	Normal (4)	Normal (9 ft/sec)
7/20 7/20	2 3*	Characterize performance versus L/G with normal pH and normal velocity	SO ₂ removal Utilization Relative sat.	5.6 5.6	5 3	8.7 ft/sec 9.8 ft/sec
7/21 7/21 7/21	4 5* 5A	Characterize performance versus L/G with low pH and normal velocity	SO ₂ removal Utilization Relative sat.	5.2 5.2	3 5 4	9.4 ft/sec 8.7 ft/sec
7/22 7/22 7/22	6 7 7A*	Characterize performance versus L/G with high pH and normal velocity	SO ₂ removal Utilization Relative sat.	5.8 5.8 5.8	3 5 5	9.3 ft/sec 8.5 ft/sec 6.5 ft/sec
7/23	8	Characterize performance as a function at flue gas velocity at normal pH, constant L	SO ₂ removal Utilization Relative sat.	5.6	5	6.2 ft/sec

* During these tests, the outlet duct was also traversed using a portable SO₂ monitor to measure SO₂ distribution across the duct.

monitor. These results were in very good agreement. Therefore, only the outlet duct was sampled during the remaining tests. Six SO₂ and velocity traverses of the Module E outlet duct were completed at Test 1 conditions on 7/19, the second day of this test. Slurry samples were collected according to the sampling plan and three settling tests were done.

Tests 2 and 3 were completed on the third test day. For these tests, the pH setpoint remained at 5.6, and the number of operating pumps was varied (5 pumps for Test 2 and 3 pumps for Test 3). The flue gas velocity changed by less than 10% when the number of pumps was changed. Following the normal Method 6 SO₂ traverse for Test 3, the outlet duct was traversed with a portable SO₂ monitor so that differences in SO₂ concentration with position in the duct could be evaluated.

Tests 4 and 5 were completed on the fourth test day. For these tests, the pH setpoint was lowered to 5.2, and the number of operating pumps was varied. The portable monitor was again used following Test 5. Because extra time was available, an extra test (Test 5A) was added to the series so that performance could be compared with 3, 4, and 5 pumps operating.

Tests 6 and 7 were completed on the fifth test day. For these tests, the pH setpoint was increased to 5.8, which was the highest pH that could be maintained by the limestone delivery system. The number of operating pumps was varied. These tests were completed in the morning. The pH setpoint was then lowered to 5.6 in an attempt to establish conditions for Test 8. However, because of the large amount of excess limestone in the reaction tank, the pH could not be lowered in time to do a test at pH 5.6. Instead, the extra time was used to add a test (Test 7A). In this test, a fifth module was brought on line to lower the velocity in the test module. Then, the outlet flue gas was traversed with the portable monitor to evaluate the effect of flue gas velocity on the SO₂ distribution across the test module. No other samples were taken during this extra test.

The final test, Test 8, was completed at the normal pH setpoint of 5.6 on the following day with five modules on line to lower the gas velocity.

3.1.2 Test Results

Available test results are presented below. The SO₂ removal data are based on on-site titrations of the peroxide impingers. In previous tests, close agreement was seen between the on-site and off-site analyses.

SO₂ Removal Efficiency

Table 2 summarizes preliminary SO₂ removal results for the baseline tests. For each entry, the "on-site SO₂" represents the concentration calculated based on titration of the peroxide impinger from the Method 6 sample train. The "inlet on-line meter" column is the average of readings recorded every ten minutes during the outlet flue gas traverses. The "slurry pH" is that measured by the Radian engineer with a calibrated portable meter. In most cases (except Test 6), the portable meter agreed closely with the control room indicator. The "gas velocity" was calculated from the outlet duct pitot traverse, adjusted to the scrubber cross sectional area. The "velocity-adjusted NTU" is calculated as $\ln(\text{SO}_{2\text{in}}/\text{SO}_{2\text{out}}) \cdot V/9$, where V is the measured scrubber gas velocity in ft/s. This adjustment corrects for differences in performance due to minor changes in gas velocity among the tests. The "L/G" was calculated using the measured flue gas volumes and pump flows for each test.

In Table 2, the first three rows are the results of the inlet SO₂ determinations done prior to Test 1. The Method 6 flue gas traverse averaged about 4% lower than the online analyzer. This is considered very good agreement.

Table 2
Results of Baseline Tests

Sample Location	Test No.	Run No.	Date	Time	On-site SO ₂ (ppm-dry)	Inlet On-line Meter	SO ₂ Removal Efficiency	Slurry pH	Gas Velocity (ft/s)	Velocity Adjusted NTU	L/G (gal/kacf)
Inlet	p	1	7/18/94	1412-1442	1295	1352	-	-	-	-	-
Inlet	p	2	7/18/94	1450-1520	1330	1353	-	-	-	-	-
Inlet	p	3	7/18/94	1533-1603	1223	1305	-	-	-	-	-
Outlet	1	1	7/19/94	0900-1040	185	1567	88.2	5.66	9.1	2.16	85
Outlet	1	2	7/19/94	1104-1159	214	1570	86.4	5.62	9.1	2.01	85
Outlet	1	3	7/19/94	1353-1423	209	1548	86.5	5.60	8.9	1.98	87
Outlet	1	4	7/19/94	1444-1514	212	1532	86.1	5.60	8.8	1.93	88
Outlet	1	5	7/19/94	1534-1617	195	1453	86.6	5.64	9.1	2.03	86
Outlet	1	6	7/19/94	1635-1705	180	1504	88.0	5.68	8.7	2.05	85
Outlet	2	1	7/20/94	0943-1018	103	1479	93.0	5.58	8.6	2.55	111
Outlet	2	2	7/20/94	1040-1110	142	1574	91.0	5.56	8.9	2.38	108
Outlet	3	1	7/20/94	1403-1433	324	1565	79.3	5.60	10.0	1.75	59
Outlet	3	2	7/20/94	1452-1522	312	1495	79.1	5.58	9.6	1.67	62
Outlet	4	1	7/21/94	0824-0854	572	1800	68.2	5.03	9.3	1.18	63
Outlet	4	2	7/21/94	0916-0947	582	1808	67.8	5.00	9.4	1.18	62
Outlet	5	1	7/21/94	1032-1103	253	1760	85.6	5.18	8.4	1.81	113
Outlet	5	2	7/21/94	1121-1152	304	1697	82.1	5.18	8.9	1.70	107
Outlet	5A	1	7/21/94	1604-1632	408	1697	76.0	4.94	9.4	1.49	82
Outlet	6	1	7/22/94	0912-0939	195	1683	88.4	5.65*	9.4	2.25	62
Outlet	6	2	7/22/94	0956-1023	193	1700	88.7	5.64*	9.2	2.22	64
Outlet	7	1	7/22/94	1045-1112	73	1724	95.8	5.81	8.5	2.99	112
Outlet	7	2	7/22/94	1130-1157	54	1692	96.8	5.82	8.4	3.21	114
Outlet	8	1	7/23/94	0830-0857	51	1315	96.2	5.60	6.2	2.24	155
Outlet	8	2	7/23/94	0914-0941	51	1353	96.2	5.60	6.3	2.29	153

* These pH readings are questionable.

Six outlet traverses were completed during Test 1. For this test at normal operating conditions (4 towers, 4 pumps, pH = 5.6), the SO₂ removal efficiency averaged 87% with a standard deviation of only 1%. The pH remained relatively constant during this test.

Tests 2 and 3 were completed at the same operating pH with 5 and 3 recycle pumps operating, respectively. Operation with 5 pumps increased SO₂ removal to an average of 92% and operation with 3 pumps decreased removal to 79%.

For Tests 4 and 5, the pH setpoint was decreased to 5.2. At this pH, the amount of excess limestone in the reaction tank is relatively small, and the pH controller was seen to cycle about 0.2 pH units above and below the setpoint with a frequency of about 1/2 hour. The Kintigh instrument technician was able to decrease the band width of this cycle to ± 0.1 pH units by decreasing the proportional constant in the controller. At this low pH, the SO₂ removal efficiency averages ranged from 68% with 3 pumps operating to 84% with 5 operating.

For Tests 6 and 7, the pH setpoint was increased to 5.9, but the pH did not reach the setpoint with the limestone slurry valve 100% open. Some difficulty in measuring the pH was encountered during Test 6. The portable meter was reading about 0.2 units lower than the on-line meter, even though they had agreed closely in all of the previous tests. The solids analyses for solid carbonate content, when they become available, should indicate whether these measurements are suspect. At the high pH setpoint, the SO₂ removal efficiency averages ranged from 88% with 3 pumps operating to 96% with 5 operating.

For the final test, one additional tower was brought on line and 5 pumps were operated on the test module. This decreased the flue gas velocity from the normal 9 ft/s to only 6.2 ft/s. Under these conditions, the SO₂ removal efficiency increased to 96% at the normal pH of 5.6 compared to 87% at the normal velocity.

The results in Table 2 have been plotted in Figure 2. In this figure, the velocity-adjusted "number of transfer units" (NTU) is plotted versus L/G with pH as a parameter. SO₂ removal efficiency is also indicated on this figure for convenience. The increase in NTU with increasing L/G appears to be roughly linear over the range tested, but the slope of the line is somewhat less than expected based on previous testing at other units. For example, increasing L/G from 60 to 110 at the normal operating pH, a factor of about 1.8, increased NTU by a factor of about 1.5. In tests at the PSI Energy Gibson Station and at EPRI's HSTC, NTU increased in direct proportion to L/G.

This lower-than-expected increase in NTU with L/G cannot be accounted for by differences in header elevation. During 3-pump operation, the pumps supplied the two lowest headers plus the top header. Therefore, with 5-pump operation, the two additional headers were higher than two of the three headers in the other tests and should have been at least as effective in adding surface area.

CEM Traverse Data

Figure 3 shows the results of the outlet duct traverses done with the portable SO₂ analyzer. The numbers inside the squares represent the measured SO₂ concentrations at the indicated positions in the duct. The numbers to the right of and below the squares are the average concentrations for the respective rows and columns.

Three tests were done to examine the distribution of SO₂ across the outlet duct. The first two were done at the same gas velocity in the scrubber (4 Modules on line) but with different numbers of recycle pumps operating (3 and 5). The third test was done with lower gas velocity obtained by bringing a fifth module on line. The results show that there is some variation in SO₂ concentration across the outlet duct and presumably across the module. A comparison of the first two tests shows that the number of operating pumps did not have a strong effect on the

Figure 2. Kintigh Baseline SO₂ Removal Results
(Adjusted NTU vs. L/G)

Test 3
4 Modules, 3 Pumps,
and pH 5.6

275	265	205	235	245
272	230	159	215	219
255	160	98	160	168
220	136	43	170	142
210	194	170	185	190
217	226	220	216	220
240	202	149	197	

Test 5
4 Modules, 5 Pumps,
and pH 5.2

312	275	170	225	246
298	215	120	215	212
335	160	120	218	208
390	165	60	296	228
325	255	315	300	299
365	325	365	360	354
338	232	192	269	

Test 7A
5 Modules, 5 Pumps,
and pH 5.8

34	13	0	8	14
41	11	0	9	15
61	17	0	9	22
71	50	8	22	38
50	60	40	29	45
54	53	51	35	48
52	34	17	19

Figure 3. Results of CEM Traverses at Module E Outlet (ppm SO₂ dry)

SO₂ distribution across the duct. The lowest readings remained in the same relative position. The highest readings shifted from the top of the duct in the 3-pump test to the bottom of the duct in the 5-pump test, but these differences were not large.

The change in gas velocity had a more noticeable effect on SO₂ distribution across the duct. With the lower velocity, the lowest readings shifted to the top of the duct, and the average across the top of the duct was much lower than the average across the bottom of the duct. The averages down the right-hand side of the duct were also much lower than those down the left-hand side. Apparently, at low velocity, the inlet flue gas does not penetrate as well to the rear of the absorber module (across from the inlet).

Settling Test Results

Four settling tests were done during Baseline Test 1. The raw data have been used to calculate thickener unit areas (ft²/ton/day) required to produce a 30 wt% underflow solids content. These calculations were based on estimated slurry solids contents and may change slightly when the actual slurry solids content data become available. The results are summarized in Table 3. The calculated unit area of about 10 to 12 ft²/ton/day indicates a relatively fast-settling sulfite sludge.

Table 3
Results of Baseline Settling Tests

Settling Test Number	Date	Time	Unit Area (ft ² /ton/day)	Final Settled Solids Content
1	7/18	1529	10	59
2	7/19	0800	10	56
3	7/19	1340	12	49
4	7/19	1435	12	56

4.4 Recycle Pump Flow Measurements

Recycle pump flow measurements were done using an ultrasonic Doppler flow meter. Each pump was tested several times during the week of the baseline tests. Pump amperage and discharge pressures were also recorded. Results are summarized in Table 4. The flow measurements were reproducible, and the recorded flows agreed well with those expected based on the 10,900 gpm nominal capacity rating for these pumps.

Table 4
Results of Recycle Pump Flow Measurements

Pump No.	Individual Flow Measurements				Average Flow	Average Amps	Average Discharge Pressure (psig)
	7/18	7/19	7/20	7/21			
1	9850	9700	9650	9700	9725	45	N/A
2	10600	10500	10600	10500	10550	42	36
3	11650	12000	11300	11400	11600	44	34
4	-	-	10500	10000	10250	44	38
5	10250	10200	10400	10350	10300	42	37

4.5 Other Process Data

Other hourly-average process data were recorded from the plant data acquisition system or from control room indicators. These data are summarized in Table 5.

Table 5
Kintigh Baseline Test Control Room Data

Test No.	Run No.	Date	Time	Gross Load (MW)	O ₂ Boiler (%) ¹	O ₂ FGD in (%)	FGD In Temp (F)	FGD In SO ₂ (ppm)	FGD In SO ₂ (lb/MBtu)	Stack SO ₂ (lb/MBtu)	Stack CO ₂ (%)	Stack Temp (F)	ID Fan Current (amps) ²	FGD in Pressure (in WG)	Bypass Damper (% open) ³	Module E ΔP (in WG)
p	1	7/18/94	1412-1442	-	-	-	-	1338	-	-	-	-	-	-	-	-
p	2	7/18/94	1450-1520	693	3	6.7	300	1352	3.17	0.59	12	129	510	4.5	6.2	-
p	3	7/18/94	1533-1603	692	3	6.8	301	1329	3.14	0.59	12	129	510	4.5	6.2	-
1	1	7/19/94	0900-1040	690	3.1	6.7	300	1567	3.74	0.57	11.9	130	519	4.8	12.4	2.2
1	2	7/19/94	1104-1159	691	3	6.7	301	1567	3.75	0.56	11.9	130	520	4.7	8.0	2.3
1	3	7/19/94	1353-1423	699	3	6.8	300	1578	3.78	0.54	12	130	520	4.8	8.0	2.3
1	4	7/19/94	1444-1514	698	3.1	6.9	300	1530	3.68	0.55	11.9	129	536	5	8.0	2.3
1	5	7/19/94	1534-1617	700	3.8	7.3	302	1477	3.45	0.49	11.4	129	522	4.9	8.0	2.3
1	6	7/19/94	1635-1705	693	3.4	7.1	302	1472	3.54	0.51	11.6	129	517	4.8	8.1	2.3
2	1	7/20/94	0943-1018	694	3.3	7	300	1367	3.37	0.65	12	129	522	4.8	6.4	2.5
2	2	7/20/94	1040-1110	697	3.3	6.9	302	1543	3.78	0.58	11.9	129	527	5.1	8.6	2.5
3	1	7/20/94	1403-1433	697	3.5	7	305	1596	3.81	0.54	11.6	129	548	5.2	7.0	2.4
3	2	7/20/94	1452-1522	696	3.4	7	304	1538	3.61	0.5	11.6	129	538	5	6.9	2.4
4	1	7/21/94	0824-0854	695	3.2	7.2	303	1768	4.42	0.64	11.7	127	527	5.2	0.0	2.2
4	2	7/21/94	0916-0947	702	3	6.9	303	1801	4.42	0.62	11.9	128	526	5.2	8.4	2.2
5	1	7/21/94	1032-1103	704	3.2	7.1	304	1763	4.34	0.59	11.7	129	531	5.3	17.8	2.4
5	2	7/21/94	1121-1152	704	3.1	7.2	304	1734	4.28	0.59	11.7	131	530	5.3	17.2	2.6

Table 5
Continued

Test No.	Run No.	Date	Time	Gross Load (MW)	O ₂ Boiler (%) ¹	O ₂ FGD in (%)	FGD In Temp (F)	FGD In SO ₂ (ppm)	FGD In SO ₂ (lb/MBtu)	Stack SO ₂ (lb/MBtu)	Stack CO ₂ (%)	Stack Temp (F)	ID Fan Current (amps) ²	FGD In Pressure (in WG)	Bypass Damper (% open) ³	Module E ΔP (in WG)
5A	1	7/21/94	1604-1632	694	3.2	7	305	1804	4.38	0.59	11.4	130	530	5.4	0.0	2.4
6	1	7/22/94	0912-0939	693	3.0	6.6	304	1538	3.99	0.61	12.0	13.0	480	4.7	4.7	2.0
6	2	7/22/94	0956-1023	693	3.0	6.6	305	1660	4.03	0.57	11.9	12.9	478	4.7	11.6	2.0
7	1	7/22/94	1045-1112	696	3.1	6.7	305	1660	4.07	0.56	11.8	13.1	526	5.0	13.9	2.5
7	2	7/22/94	1130-1157	698	3.1	6.7	305	1706	4.05	0.56	11.8	13.1	519	4.9	17.0	2.5
8	1	7/23/94	0830-0857	700	3.1	6.6	220	1267	3.09	0.51	11.9	12.7	505	3.7	0.8	2.0
8	2	7/23/94	0914-0941	709	3.0	6.6	245	1320	3.23	0.51	12.1	12.7	515	4.2	0.8	2.0

Notes:

- (1) Boiler % O₂ is average of east & west monitors
- (2) ID fan motor current is sum of amps on fans 1A, 1B, & 1C
- (3) Bypass damper A position is shown; other bypass dampers are closed

4.0

PLANS FOR THE NEXT REPORTING PERIOD

All of the testing planned for this project has been completed. Efforts during the fourth quarter of calendar year 1994 will only consist of data reduction and reporting. The base program (Tampa Electric Big Bend) and Options I and II (Hoosier Energy Merom and SWEPCo Pirkey, respectively) are in the final reporting phases. Draft Topical Reports for the Tampa Electric and Hoosier Energy sites were previously submitted. These drafts will not be revised until review comments are received from DOE and the utilities. For the SWEPCo site, the draft version of that Topical Report should be completed during the fourth quarter of calendar year 1994.

For the PSI Energy Gibson Station (Option III), a Technical Note summarizing results from the sodium formate parametric tests and additive consumption test was completed in early April 1994. Since earlier this year, a DBA additive performance and consumption test was completed as well. Results from the DBA tests will be incorporated into a revised Technical Note for this site, which should be distributed for review and comments late in the fourth quarter or early in the first quarter of calendar year 1995.

Parametric testing of the most favorable upgrade options for the Duquesne Light Elrama site (Option IV) has been completed, as mentioned in the previous sections. A draft Technical Note should be completed during the next quarter summarizing baseline and parametric test results of FGDPRISM modeling and of economic evaluations for the upgrade options tested.

For Option V, testing at the New York State Electric and Gas Company Kintigh Station, baseline, parametric, and sodium formate additive consumption testing were completed in the third quarter. A draft Technical Note summarizing these test results and the results of FGDPRISM modeling and economic evaluations for this site should be submitted late in the fourth quarter.