**ELECTRIC POWER RESEARCH INSTITUTE
ENVIRONMENTAL CONTROL TECHNOLOGY CENTER**

REPORT TO THE STEERING COMMITTEE

Monthly Technical Progress Report

**US/DOE Patent Clearance is not Required
Prior to the Publication of this Document**

February 1997

Prepared by:

**EPRI/ECTC
Radian International
Parsons Power**

**June 13, 1997
DOE Grant #DE-FG22-94PC93256**

**EPRI ECTC
7725 Lake Road
Barker, New York 14012**

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.

CAUTIONS TO USE OF THIS REPORT

This report is a compilation of monthly progress reports by EPRI contractors (Radian International, Parsons Power) connected with the Environmental Control Technology Center (ECTC). This report is intended to provide timely information regarding the status of testing and research to the ECTC co-sponsoring organizations. All data, results, and remarks contained in this report should be considered preliminary based on the information available to date. Any speculation or conclusions discussed in this report are subject to change as additional information becomes available.

Neither EPRI, members of EPRI, Radian International, Parsons Power, or any person acting on behalf of any of them makes any warranty, express or implied, with respect to the use of any information, apparatus, method, or process disclosed in this report, or that any such use may not infringe privately owned rights. Neither EPRI, members of EPRI, Radian International, Parsons Power, or any person acting on behalf of any of them assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

For further information on:

Facility Operations and Miscellaneous ECTC inquiries;
contact - Gary Andes (716) 795-3397

Wet FGD/Toxics Testing, Spray Drying/Dry FGD/Duct Injection technologies;
contact - Richard Rhudy (415) 855-2421

TABLE OF CONTENTS

- I. EXECUTIVE SUMMARY**

- II. FACILITY STATUS**
 - General
 - Clear Liquor Scrubbing with Anhydrite Production
 - Semi-Continuous Mercury Analyzer
 - B&W/Condensing Heat Exchanger (CHX) System
 - Miscellaneous Systems
 - Financial Report

- III. PILOT AND MINI-PILOT TEST ACTIVITY**
 - Testing Overview
 - Summary of Operations
 - Summary of Results
 - Future Testing

- IV. APPENDIX A Test Schedules**

EXECUTIVE SUMMARY

General Operations

Operations and maintenance continued this month at the Electric Power Research Institute's (EPRI's) Environmental Control Technology Center (ECTC). Testing for the month continued with the Phase I DOE/PRDA investigation of the Clear Liquor Scrubbing Process with Anhydrite Production and Chloride Control.

The Phase I DOE/PRDA testing of the B&W/Condensing Heat Exchanger (CHX) also continued this month as the inlet particulate control system (installed September 1996) is maintaining the inlet particulate mass loading to the unit at an average value of 0.2 lb./MMBTU. The one-year tube wear analysis project conducted across this unit will be completed in the early part of March. At the completion of testing, a final inspection will be conducted before the unit is cleaned, disassembled, and returned to B&W and CHX Corp. for additional analysis. Once the unit is removed from the ECTC, the 0.4 MW Mini-Pilot Wet Scrubber unit will be assembled and configured back into the flue gas path for future testing.

The 1.0 MW Cold-Side Selective Catalytic Reduction (SCR) unit and the Carbon Injection System (the Pulse-Jet Fabric Filter configuration) remained idle this month in a cold-standby mode and were inspected regularly.

Pilot Testing Highlights

In February 1997, the Clear Liquor Scrubbing with Anhydrite Production test block continued. This PRDA project is being jointly funded by the Electric Power Research Institute and the Department of Energy and is part of the DOE's Advanced Power Systems Program, whose mission is to accelerate the commercialization of affordable, high-efficiency, low-emission, coal-fueled electric generating technologies. The pilot portion of the CLS/Anhydrite project is being conducted on the 4.0 MW wet FGD pilot unit at EPRI's Environmental Control Technology Center (ECTC). The project is designed to develop an advanced FGD process incorporating chloride control, clear liquor scrubbing, and anhydrite (anhydrous calcium sulfate) production.

While the three areas of the integrated process can be used independently, they work together in a manner that benefits the overall process. The HCl control process involves controlled humidification of the flue gas with a slurry containing a calcium-based alkali. The potential advantages of the HCl control process include:

- Helps control scaling in CLS process and increases the anhydrite production rate.
- Reduces the chloride concentration in FGD solutions which reduces the corrosion rate of alloys and increases the limestone dissolution rate (through calcium common ion effect).

The clear liquor scrubbing process uses an organic buffer to provide sufficient liquid-phase alkalinity to achieve the necessary SO₂ removal efficiency. The calcium sulfite solids produced from neutralizing the spent scrubber liquor with limestone are separated from the liquid in the sludge bed reactor. The resulting clear liquor stream is recirculated to the absorber. The clear liquor scrubbing process provides the following potential benefits:

- Smaller absorber (use of enhanced mass transfer media such as packing).
- Lower L/G.
- Reduced absorber pluggage (no solids).
- Better solids dewatering properties (no recirculation).

The calcium sulfite slurry from the sludge bed reactor is sent to the anhydrite reactor for conversion to anhydrous calcium sulfate (anhydrite). The anhydrite process offers the following potential advantages:

- Byproduct differs from gypsum and is potentially more valuable:
 - “Reactive” without calcination
 - Used in other markets such as self-leveling floors, aggregate, Portland cement.
- Attractive option for either new or existing inhibited oxidation systems by producing a useful byproduct.

The original objective in the PRDA project was to demonstrate all three areas of the integrated process. However, the primary focus has been on anhydrite production for the following reasons:

- Of the three proposed processes, the anhydrite process is the least developed and potentially the most valuable,
- Initial anhydrite tests were encouraging, and
- DOE has placed emphasis on the reuse of byproduct materials.

The objectives of ECTC anhydrite test block are to:

- Produce anhydrite solids from FGD calcium sulfite slurry;
- Evaluate the effect of residence time, ionic strength, and temperature on anhydrite production;
- Characterize the anhydrite properties;
- Estimate the potential value of the anhydrite byproduct; and
- Estimate the overall production costs.

FACILITY STATUS

General

The NYSEG Kintigh Station provided flue gas to the Center 100% of the time during this performance period; no facility outages were incurred this month. As the Station operated with a variety of coals, fluctuations in the Center's inlet SO₂ concentrations were experienced and SO₂ spiking was initiated across the test units as required.

Safety training for the month was conducted by the Operations Manager, Maintenance Supervisor, and Shift Supervisors. Also, the annual OSHA safety program compliance training continued this month at the NYSEG training center on-site. The annual ECTC employee physical program began this month at the local hospital clinic; this program is scheduled to be completed by mid-March. Inspections of the ECTC Facility and safety equipment (SCR air-packs, fire extinguishers, etc.) were completed and recorded this month. All systems were found to be in good condition. By continuing to emphasize safe work habits at the Center, we have raised the total number of days without a lost time injury to 1730 as of 2/28/97.

The monthly safety meeting with the NYSEG Kintigh Station and the EPRI ECTC was held on February 4, 1997 with both NYSEG and ECTC representatives. The major topics of discussion were the ongoing OSHA compliance safety training program and the schedule for future training activities/programs to be held at the Station. The schedule for alternate fuels blending/co-firing at the Station, and the May '97 scheduled Station outage were also discussed.

Pilot Wet FGD System

The equivalent and actual availability for the ECTC 4.0 MW Pilot Wet FGD System testing this month were both 100% during this period.

The Phase I DOE/PRDA Clear Liquor Scrubbing Process testing with Anhydrite Production continued this month with tests ANH-2, ANH-3, ANH-4, ANH-5, ANH-6, ANH-7, ANH-8, and ANH-9. These tests were designed to develop the production process for the anhydrous calcium sulfate (anhydrite), and to study the solids properties of the resulting byproduct. The operational parameters for the Pilot Wet Scrubber during this test block included: gas flows of 8,250 scfm; inlet SO₂ concentrations of 1200 to 1500 ppm; recycle slurry flows of 1300 to 1700 gpm; and 30 to 60 scfm of oxidation air.

The Chloride Control phase of the Pilot process testing was conducted concurrently with the anhydrite production testing this month. This test phase was initiated with tests ICC-1, ICC-2, ICC-3, and ICC-4. These tests utilized the Spray Dryer Absorber (SDA) System (upstream of the ESP and Pilot FGD unit) with the rotary atomizer in service to inject various flows of lime slurry reagents into the gas stream. The SDA outlet gas temperature during these tests was controlled to 200°F

and 225°F.

The following maintenance work was completed on the Pilot FGD System during this performance period:

- The stator, rotor and seal were replaced in Centrifuge feed pump 8.
- The solid deposits in the SDA inlet ductwork (from lime slurry injection) were cleared and removed.
- The hoses were replaced in the heated water tank several times.
- Two flow transmitters were installed for the slurry hydrocyclone operation.
- The Nylon cloth on the VBF was replaced with a Dacron cloth with a tighter weave to reduce shrinkage.
- The VBF cloth wash system was modified with additional nozzles to enhance the cloth washing capabilities.
- The flow transmitter was repaired for pump 8.
- Local controls were installed for pump 14.
- The seal was replaced in pump 17a.
- Additional insulation (R25) was added to the existing insulation (R11) on the FLRT (Anhydrite reaction tank).
- The small-scale hammer mill was repaired (new motor) to grind the ECTC anhydrite solids.

Semi-Continuous Mercury Analyzer

Testing of the EPRI Semi-Continuous Mercury Analyzer resumed this month as additional comparative sampling was conducted using the analyzer and Method 29T for mercury speciation measurement. During this performance period, the analyzer and its components were moved to the particulate-free Clean Raw Gas (CRG) duct. Elemental mercury was injected (spiked) into the flue gas (prior to the ESP booster fan for good mixing) at a location upstream of the CRG sampling point for this testing. Simultaneous gas sampling was then conducted for total, elemental, and oxidized mercury species in the CRG duct utilizing the Semi-Continuous Mercury Analyzer and Method 29T for comparison.

B&W/Condensing Heat Exchanger (CHX) Project

The equivalent and actual availability for the B&W/Condensing Heat Exchanger (CHX) unit were both 92% during this period. The System did not operate during the following periods this month:

- February 10 - 12 for 52 hours due to a system outage to inspect, disassemble, clean, and reassemble the heat exchanger. A new heat exchanger wash system was also designed and installed during this outage period.

Operations and testing across the B&W CHX unit for the Phase I DOE/PRDA program continued this month. The control system for the inlet flue gas flow damper (installed September 1996) continued to allow the inlet particulate mass loading to the unit to be maintained at an average value of 0.2 lb./MMBTU. During this performance period, a set of EPA Reference method gas samples (Method 5 and Method 2) were collected to verify the inlet particulate mass loading and flue gas flow velocity through the CHX unit.

During the January '97 inspection of the CHX unit, it was determined that deposits of fly ash/solids were accumulating on the heat exchanger tubes near the middle and bottom sections and were not being effectively washed from the unit during normal on-line cleaning. Therefore, B&W requested that the heat exchanger unit be disassembled and cleaned (both manually and with a high pressure water wash). The unit was disassembled and cleaned on February 10; samples of the fly ash solids and wash waters were collected and sent to B&W for analysis with pictures that documented the inspection and cleaning of the unit. Additionally, to improve the on-line cleaning efficiency of the heat exchanger unit, a new water wash header/nozzle assembly (with two more Teflon[®] nozzles) was designed and installed in the upper hood of the unit. The unit was returned to service on February 12 for continued testing and tube wear analysis studies.

Miscellaneous

Normal Ball Mill operations continued at the ECTC this month to provide process reagent for the Clear Liquor Scrubbing with Anhydrite Production test block. The Beachville limestone prepared for the testing this period was maintained at a grind of 90% passing 325 mesh screen.

The following general maintenance work was completed at the ECTC during this performance period:

- Preventive maintenance was completed on several pieces of ECTC equipment and their components.
- The ECTC dump truck bed and solids hoppers were cleaned with a pneumatic hammer to remove the heavy buildup of hard gypsum anhydrite solids produced from the current testing.
- The Facility sump/trench system was manually cleaned to remove the buildup of gypsum anhydrite solids carried over into the water/filtrate collection system.

Financial Report

The Financial Report for the four Operations and Maintenance contract tasks are summarized below for the month of February 1997, the year to date, and the contract total.

Task Definitions:

Task 100: Operations and Maintenance Labor

Task 200: Purchased Materials

Task 300: Engineering Support

Task 400: Training

Table i.
Monthly Operating Costs by Task

	February	Year to Date	Contract Total
Task 100	\$ -----	\$ -----	\$ 14,479,009
Task 200	\$ 3,271	\$ 5,872	\$ 8,517,068
Task 300	\$ 2,100	\$ 5,775	\$ 1,200,362
Task 400	\$ -----	\$ -----	\$ 53,235
DOE Grant	\$ 30,688	\$ 65,760	\$ 181,936
TOTAL	\$ 36,059	\$ 77,407	\$ 24,431,610

The attached graph illustrates the budgeted and actual expenses for ECTC O&M activities through February 1997.

Figure i.
1997 Operation & Maintenance Costs

PILOT AND MINI-PILOT TEST ACTIVITY

Testing Overview

In February 1997, the Clear Liquor Scrubbing with Anhydrite Production test block continued. This PRDA project is being jointly funded by the Electric Power Research Institute and the Department of Energy and is part of the DOE's Advanced Power Systems Program, whose mission is to accelerate the commercialization of affordable, high-efficiency, low-emission, coal-fueled electric generating technologies. The pilot portion of the CLS/Anhydrite project is being conducted on the 4.0 MW wet FGD pilot unit at EPRI's Environmental Control Technology Center (ECTC). The project is designed to develop an advanced FGD process incorporating chloride control, clear liquor scrubbing, and anhydrite (anhydrous calcium sulfate) production. A conceptual process flow diagram including all three aspects of the process is included as Figure 1.

Figure 1. Conceptual Process Flow Diagram for the Clear Liquor Scrubbing with Anhydrite Production Process

While the three areas of the integrated process can be used independently, they work together in a manner that benefits the overall process. The HCl control process involves controlled humidification of the flue gas with a slurry containing a calcium-based alkali. The potential advantages of the HCl control process include:

- Helps control scaling in CLS process and increases the anhydrite production rate.
- Reduces the chloride concentration in FGD solutions which reduces the corrosion rate of alloys and increases the limestone dissolution rate (through calcium common ion effect).

The clear liquor scrubbing process uses an organic buffer to provide sufficient liquid-phase alkalinity to achieve the necessary SO₂ removal efficiency. The calcium sulfite solids produced from neutralizing the spent scrubber liquor with limestone are separated from the liquid in the sludge bed reactor. The resulting clear liquor stream is recirculated to the absorber. The clear liquor scrubbing process provides the following potential benefits:

- Smaller absorber (use of enhanced mass transfer media such as packing).
- Lower L/G.
- Reduced absorber pluggage (no solids).
- Better solids dewatering properties (no recirculation).

The calcium sulfite slurry from the sludge bed reactor is sent to the anhydrite reactor for conversion to anhydrous calcium sulfate (anhydrite). The anhydrite process offers the following potential advantages:

- Byproduct differs from gypsum and is potentially more valuable:
 - “Reactive” without calcination
 - Used in other markets such as self-leveling floors, aggregate, Portland cement.
- Attractive option for either new or existing inhibited oxidation systems by producing a useful byproduct.

The original objective in the PRDA project was to demonstrate all three areas of the integrated process. However, the primary focus has been on anhydrite production for the following reasons:

- Of the three proposed processes, the anhydrite process is the least developed and potentially the most valuable,
- Initial anhydrite tests were encouraging, and
- DOE has placed emphasis on the reuse of byproduct materials.

The objectives of ECTC anhydrite test block are to:

- Produce anhydrite solids from FGD calcium sulfite slurry;
- Evaluate the effect of residence time, ionic strength, and temperature on anhydrite production;

- Characterize the anhydrite properties;
- Estimate the potential value of the anhydrite byproduct; and
- Estimate the overall production costs.

Operating Summary

The pilot activities began following a laboratory investigation of anhydrite equilibrium and kinetics and a preliminary anhydrite market survey. The initial pilot tests focused on production of anhydrite since this is the least well developed of the three areas included in this process. The ECTC pilot configuration used in this test block is shown in Figure 2.

Figure 2. ECTC Flow Configuration Used During Anhydrite Process Development

A summary of the February operating conditions is presented in Table 1. As shown in the table, most of February was spent trying to maintain the production of anhydrite. Most of the temperature and pH control problems experienced in January had been solved. However, the anhydrite surface area control seems to be a key to consistently producing anhydrite.

Table 1. February 1997 Anhydrite Operations Summary

Date	Test ID- Description	Operating Summary
Sat, 2/1	ANH-2: Same as ANH-1 but with a lower ART feed rate.	The ART is at the target temperature. However, the ART pH is still higher than expected with 40 scfm air. Therefore, the ART slurry was transferred to a hold tank to inspect the ART sparge ring. The slurry was kept warm by recirculating through the heated coils.
Sun, 2/2	ANH-2	The ART was emptied, and the sparge ring was inspected. It was about 40% plugged with solids. Once cleaned, the ART was refilled to about 12 ft with the previously transferred slurry. The temperature was 40°F below the target. Slurry from the FGDRT was fed to the ART at 1 gpm, and the oxidation air rate was set at 30 scfm to maintain the target pH. These conditions were consistent with previous conditions before the sparged ring plugged.
Mon, 2/3	ANH-2	The ART temperature reached the target range by mid-afternoon. A tank fitting failed, and about 2 ft. of slurry was lost. ART feed rate was increased to 1.5 gpm and the oxidation air rate to 60 scfm to build solids more quickly.
Tue, 2/4	ANH-2	More insulation was added to the ART to maintain the target temperature more easily. Morning samples indicated 33% anhydrite. A mid-afternoon sample indicated 67% anhydrite and an early evening sample 76%. Conditions throughout this time consisted of a feed rate of 1.5 gpm, oxidation air rate of 60 scfm, and blowdown to the centrifuge.
Wed, 2/5	ANH-2	Morning and afternoon samples indicated 92% anhydrite. The vacuum belt was used with a warm water wash.
Thu, 2/6	ANH-2	The temperature has remained in the target range. Morning samples indicated 98% anhydrite while the afternoon sample indicated 93%.
Fri, 2/7	ANH-2	Took last set of final samples at ANH-2 conditions. Test conditions were then changed by increasing the pH by 0.3 units by reducing the oxidation air rate. The FGDRT solids concentration decreased from 29% to 21%.
Sat, 2/8	ANH-3: Same as ANH-2 with higher pH and lower ox. air rate.	The anhydrite concentration had decreased to 78% by the morning sample and to 67% by afternoon. The oxidation air rate had only been reduced from 60 scfm to 55 scfm to maintain the revised pH set point.
Mon, 2/10	ANH-3	Morning samples indicated 67% anhydrite and afternoon samples 61%. All target conditions were maintained.
Tue, 2/11	ANH-3	The ART temperature dropped slightly during the early morning due to a low water temperature. The temperature was still above the minimum desired. The temperature increased 2°F throughout the day. Morning and afternoon samples indicated about 45% anhydrite. The pH was decreased by 0.5 units by increasing the oxidation air rate from 46 scfm to 52 scfm. Blowdown was switched to the centrifuge, but the centrifuge soon failed. The vacuum belt was then used again.
Wed, 2/12	ANH-4: Same as ANH-2	The ART temperature was in the target range. Morning samples indicated 45% anhydrite while afternoon samples indicated 56%. Since the anhydrite concentration appeared to be increasing, conditions were maintained.

Table 1. February 1997 Anhydrite Operations Summary

Date	Test ID- Description	Operating Summary
Thu, 2/13	ANH-4	Morning samples indicated 68% anhydrite while afternoon samples indicated 70%. The anhydrite concentration appeared to be stabilizing.
Fri, 2/14	ANH-4	Morning samples indicated about the same level of anhydrite. The pH was decreased by an additional 0.3 units to determine if lower pH helped with formation of anhydrite.
Sat, 2/15	ANH-5: Same as ANH-4 with pH set point 0.3 units lower.	pH had no effect. The hydroclone was tested to concentrate anhydrite. With limited samples, there was no detectable separation of anhydrite between underflow and overflow. The first attempt was made at controlling the anhydrite surface area through external means (Mechanism 1).
Mon, 2/17	ANH-6: Trying to repeat ANH-2 but had difficulty achieving pH and solid wt%.	Morning samples indicated about 45% anhydrite, and the crystals did not appear to be affected by process change. The ART solids concentration had dropped to 11 wt% below the target. Also, the liquid sulfite concentration was low. After fixing some pH tree problems, the ART pH was very high. Increasing the oxidation air rate to 100 scfm did not lower the pH so sulfuric acid was added to achieve the target. Eventually, the target pH was obtained with 80 scfm air. The FGDRT pH is also high at 6.4.
Tue, 2/18	ANH-6	Oxidation air rate was dropped to 40 scfm to keep pH up. Liquid sulfite was higher. Conditions were similar to ANH-2 but anhydrite content was low. Added Na at 17:00 to increase liquid phase sulfite concentration. To prevent line pluggage, ART solids being removed by operating feed rate to the centrifuge on an on-off basis.
Wed, 2/19	ANH-7: Adjust liq $\text{SO}_3^{=}$ conc.	The sodium concentration had increased only slightly but the sulfite concentration had increased back into range measured in ANH-2. At 14:00, began a second attempt to control anhydrite surface area with a different external process mechanism.
Thu, 2/20	ANH-8: Surface area control-mechanism 2.	Anhydrite content increased. Centrifuge used for dewatering with batch feed. Lime injected at SDA to achieve 225°F outlet and 10 molar ratio. HCl dropped from 44 ppm to about 6 ppm.
Fri, 2/21	ANH-8	Continued to control anhydrite surface area using Mechanism 2. Lime to SDA stopped to test on-line mercury analyzer.
Sat-Sun, 2/22-2/23	ANH-8	No problems. Continued Mechanism 2 for anhydrite surface area control.
Mon, 2/24	ANH-8	Centrifuge product was collected.
Tue, 2/25	ANH-8	Five barrels of centrifuge product were collected overnight. Started collecting one 5-gal. bucket per day. Lime to SDA froze and had to be thawed.
Wed, 2/26	ANH-8	Collected last set of final samples. Lowered pH by 0.5 units using oxidation air. The lime test at 5 molar ratio resulted in 18 ppm HCl. The ratio was dropped to 2.

Table 1. February 1997 Anhydrite Operations Summary

Date	Test ID- Description	Operating Summary
Thu, 2/27	ANH-9: Same as ANH-8 but pH 0.5 units lower	pH appeared to have no effect. At 10:00, began to decrease Na and increased pH original target. 28 ppm HCl achieved at 2 molar ratio. Ratio increased to 10 and flue gas temperature dropped to 200°F.
Fri, 2/28	ANH-10: Same as ANH-8 with no soda ash addition.	The ART temperature dropped 3°F but still well within the target range. This drop is attributed to increased water addition with the ox. air. The air water rate was reduced. SDA was removed from the gas path. Started third spray header to build FGDRT solids.

Results Summary

Several analytical methods have been used to determine the phase of calcium sulfate being produced in the anhydrite reactor including:

- % Bound Water (measure solid weight loss at about 180°C)—provides an estimate of anhydrite wt% assuming solids are mixture of only anhydrite and gypsum;
- X-Ray Diffraction (XRD) - indicates the presence of gypsum, hemihydrate, and/or anhydrite;
- Visual Microscope and Scanning Electron Microscope (SEM)—indicate changes in particle size and shape; and
- ORTECH measurements—differential scanning calorimetry, gravimetric hydration phase analysis, and temperature setting characteristics.

Of these analyses, the % bound water and visual microscope measurements were made on site. These measurements, coupled with the subjective observations about the reactivity of the centrifuge or vacuum belt product, were used to make the daily decisions concerning modification of test conditions.

Figure 3 summarizes the percentage of anhydrite formed during February. The results in Figure 3 are based on the % bound water and the assumption that all of the solids are either anhydrite or gypsum. As the figure indicates, the anhydrite content of the solids increased following the recovery from the plugged oxidation air sparger which occurred in late January. Following re-establishment of the target temperature and pH, the anhydrite content in the solids increased to greater than 90% from February 5 to 7. However, the anhydrite content varied from 70 to 20% as different process variable changes were made, including at return to the conditions of the February 5 to 7 period. On February 15, the first mechanism to control anhydrite surface area in the anhydrite reactor was implemented without a noticeable change in operation. On February 19, a second mechanism was implemented. Within 2 days, the anhydrite content increased to above 90% and remained there

the remainder of the month. The surface area control mechanism also remained in effect during this period. Initial indications are that some type of external surface area control mechanism will be required to control the consistent production of anhydrite.

The centrifuge solids were somewhat reactive during February. The centrifuge product was generally above 90% solids, but the water apparently reacted with the calcium sulfate overnight to produced a hardened material that required some effort to break apart.

The XRD results showed that the solids produced in February were a mixture of hemihydrate, anhydrite, and gypsum. An SEM of the solids produced in early February is shown in Figure 4.

Figure 3. February 1997 Anhydrite Results Summary

Figure 4. SEM of Solids Produced at the ECTC on February 8, 1997

These solid crystals show more rounded ends than the gypsum produced in January. The XRD results indicate that a large portion of the solids in Figure 4 were hemihydrate.

Future Testing

Further development work with the anhydrite process is planned for March. The approaches to control anhydrite surface area for consistent production of anhydrite product will continue to be explored.

APPENDIX A
TEST SCHEDULES

1 9 9 5											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PILOT	High-Velocity FGD Testing	Lime/DBA Gypsum tests	Carbon Injection	Wet FGD Toxics Testing			Wet FGD Toxics Testing - Wet coke	Outage	High-Velocity FGD Testing	Wet FGD Toxics Testing	
				Lime/DBA Gypsum tests							
MINI-PILOT	UNIT DOWN					Lime/DBA Gypsum tests	UNIT DOWN				

	1 9 9 6												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
PILOT	EPRI Wet FGD Toxics Testing		DOE/PRDA Phase I - Mercury and HAPs Control with Wet FGD			EPRI Wet FGD Toxics Testing		Third party Testing - Rotorfilter Technology	EPRI Toxics Removal Testing	EPRI SOx/NOx Process Testing		ECTC Fall Outage	
	UNIT DOWN		DOE/PRDA Phase I - Multiple Pollutant Removal Using the Condensing Heat Exchanger (CHX)										
MINI-PILOT													

1 9 9 7 (Tentative Schedule)											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DOE/PRDA Phase I - Clear Liquor Scrubbing (CLS) with Anhydrite Production				EPRI, ECTC, and Third-Party Environmental Testing (API Phase II)					DOE/PRDA Phase II - Clear Liquor Scrubbing DOE/PRDA Phase II - Mercury and HAPs Control		
DOE/PRDA Phase I - Condensing Heat Exchanger (CHX) Testing			Reconfigure Mini-Pilot Scrubber	Unit Available for Testing							

ECTC Pilot-scale Testing Schedule ('95-'97)

ECTC COSPONSORS DISTRIBUTION

Mr. John E. Smigelski
New York State Electric & Gas
Corporate Drive, Kirkwood Ind. Park
P. O. Box 5224
Binghamton, NY 13902-5224
Ph: (607) 762-8688
Fax: (607) 762-8457

Ms. JoAnn C. Zysk
U.S. Department of Energy
Federal Energy Technology Center
P. O. Box 10940, MS 900-33
Pittsburgh, PA 15236
Ph: (412) 892-6200
Fax: (412) 892-6216

Dr. Gerald Janik
New York State Electric & Gas
Corporate Drive, Kirkwood Ind. Park
P. O. Box 5224
Binghamton, NY 13902-5224
Ph: (607) 762-4318
Fax: (607) 762-8457

Mr. Takeo Hirai
Electric Power Development Co., Ltd.
15-1, Ginza 6-Chome, Chuo-ku
Tokyo, 104 JAPAN
Ph: (81) 3-3546-9404
Fax: (81) 3-3546-9482

Ms. Debra DiMeo
Empire State Electric Energy Res. Corp.
1515 Broadway
New York, NY 10036
Ph. (212) 302-1212
Fax: (212) 302-1377

EPRI DISTRIBUTION

G. Andes
W. Chow

R. Glover
M. Miller

R. Rhudy
G. Offen

G. Preston