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Clean Coal Today

An Update of the U.S. Clean Coal Technology Demonstration Program Office of Fossil Energy, U.S. Department of Energy

Clean Coal Briefs

Progress continued in the program this quarter as **Southern Company Services'** SCR test project became the 23rd government/industry cooperative venture to move into operations (see story p. 7). Look for results and other data in future issues of *Clean Coal Today*.

Tthe **Second Annual Clean Coal Technology Conference** was held in Atlanta, GA, from September 7-9, 1993. This year's conference attracted a large number of overseas visitors who are interested in learning more about the clean coal technologies being demonstrated in the United States. Special thanks to the Southern States Energy Board for its help and hospitality this year, and to Georgia Power Company for its kind hospitality during the tour of Plant Yates. The results of the conference will be featured in the next issue of *Clean Coal Today*.

In other news, the **Ohio Coal Development Office** sponsored yet another of its highly successful technology open houses on June 25 and June 28. This time, **ABB Combustion Engineering (ABB/CE)** had an opportunity to proudly describe the excellent results it is getting from the **SNOX project at Ohio**

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Outperforming Conventional Systems

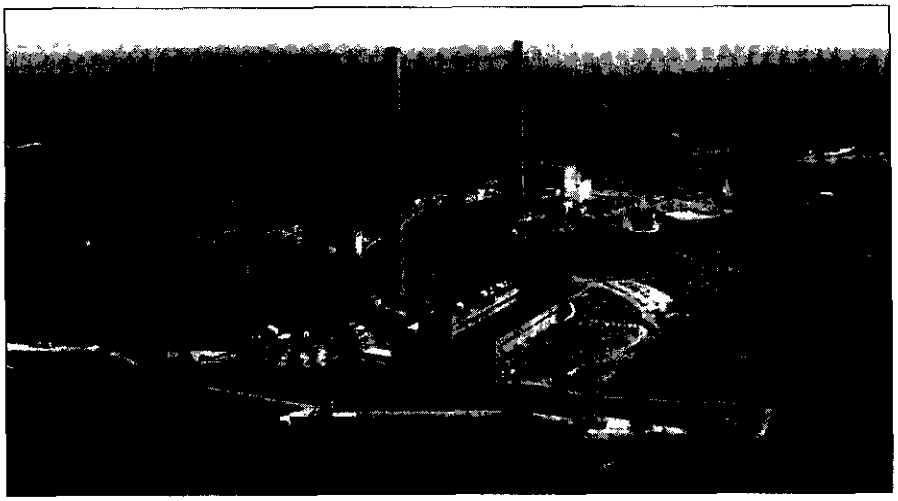
CT-121 Advanced Scrubber Moves Ahead at Georgia Site

In Newnan, Georgia, just outside of Atlanta, utility industry observers are carefully tracking the progress of a second generation flue gas desulfurization system that is outdoing itself in terms of performance, efficiency, and cost. The scrubber, called the Chiyoda CT-121, is now undergoing long-term tests on a 100-MW unit at Georgia Power Company's Plant Yates. These are the first such tests on a unit of this size using U.S. high-sulfur coals.

The long-term tests began in March, and the early results are impressive. Sulfur dioxide removal reached a high of 98.7 percent and more than 90 percent particulate removal was also achieved. The unit is maintaining a 97 percent, or better, rate of limestone utilization, a level that reflects the low pH at which the process can operate while still achieving very high levels of SO_2 removal. If these results continue— tests will run through 1994 -utilities will have yet another effective option for meeting the SO_2 requirements of the Clean Air Act Amendments while holding down costs to customers.

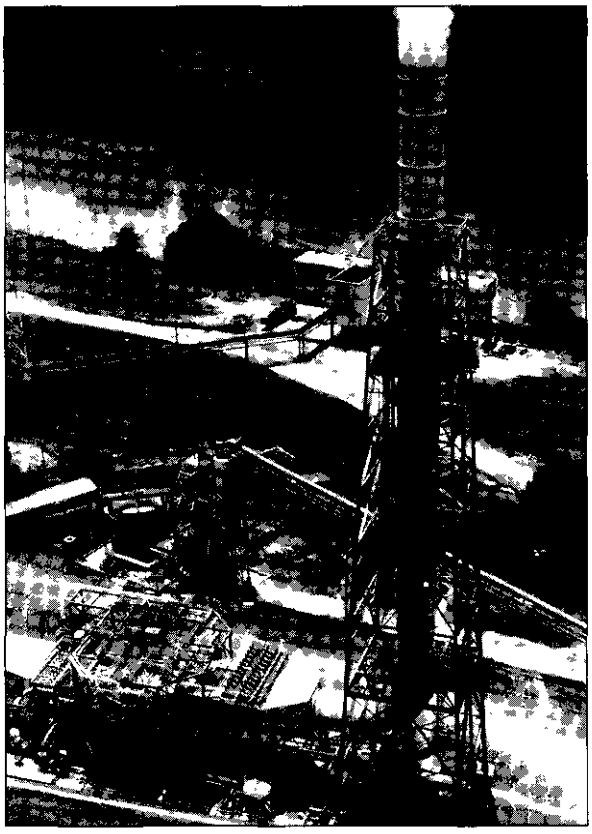
The CT-121 system features a uniquely designed vessel called a "jet bubbling reactor," or JBR, where several processes—SO_2 absorption, neutralization, gypsum crystal growth, and particulate removal—all take place in a single unit. Inside the JBR, flue gases are bubbled upward through a limestone slurry. Sulfur dioxide is absorbed by the slurry to form calcium sulfite. Air is then bubbled into the slurry so that the calcium sulfite is oxidized to calcium sulfate, or gypsum. The essentially complete utilization of limestone promoted by the low-pH process in the JBR reduces limestone costs, scaling problems, and the amount of waste produced.

See "CT-121" on page 2 . . .



Overview of Georgia Power's Plant Yates, home of the CT-121 process (located to the left of the plant).

. . . "CT-121" from page 1



The CT-121 process area showing the top of the fiberglass JBR connected to the new fiberglass stack. Both were manufactured on-site using a novel fiberglass spinning process.

Construction of this Round II Clean Coal Technology project was completed on schedule in late-1992. Parametric and optimization tests began in January and ran through March, when long-term tests began. Since the unit came on line, the scrubber has recorded 98 percent reliability and availability while logging over 5,000 hours of operation.

A total of 39 parametric tests were conducted utilizing a full factorial test matrix. Tests looked at the effects of several factors—boiler load, JBR pressure drop, inlet SO_2 concentration, and the pH of the system on SO_2 removal efficiency. Through tests with a wide range of variables, SO_2 removal ranged from 65 to 98 percent.

Radian Corporation, which conducted the parametric test operations, reported that the predictive model generated from the test data will be an exceptionally reliable tool for predicting SO_2 removal.

Data strongly suggest that the CT-121 system may well be able to obviate the need for a separate electrostatic precipitator (ESP) for particulate control. Tests show that the plant's ESP removes 99 percent of the particulate and the JBR captures 90 percent of what is left. Of that one percent, the JBR removed 90 percent of the material greater than one micron in size and up to 50 percent of the less-than-one micron material.

The scrubber's ability to capture air toxic emissions was also evaluated during the last week in June, and these results will be available later this year.

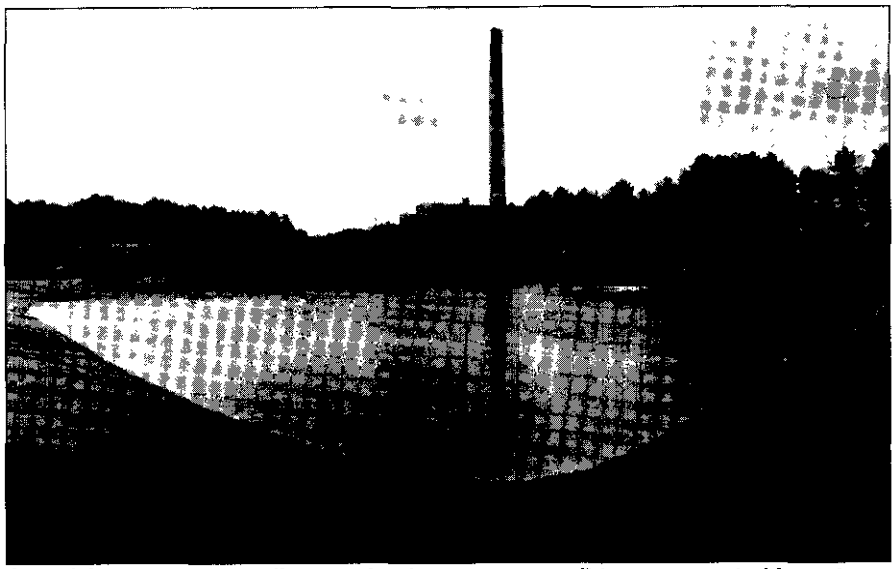
Tests with the ESP in service will continue through this summer and into the fall. The precipitator will be phased down in a series of steps until the precipitator is fully deactivated and serving only as a conduit for boiler flue gas during the second full year of testing.

Gypsum Byproduct

A key advantage of the CT-121 process is its production of a byproduct gypsum instead of a waste material. Slurry containing the gypsum crystals is continuously withdrawn from the vessel and the crystals are separated from water with a "stacking" method first developed in the phosphate fertilizer industry. With this technique, a dragline digs naturally sedimented gypsum from the bottom of the stack. This material is then used to build a dike around the edge of the stack. Gypsum-containing slurry is poured into the diked area where gravity causes the gypsum solids to settle while clear liquid flows to a recycle water pond.

At the Yates plant, an eight-acre gypsum-stacking area lined with hypalon plastic and 18 inches of clay soil was built for the stacking process. Gypsum stacking has been in progress since October 1992, and more than 35,000 tons have already been produced. With the ESP operating, gypsum production is about seven tons per hour, a level expected to double when the ESP is not used. Gypsum stacks are expected to grow to about 40 feet in height.

See "CT-121" on page 4 . . .



One of three gypsum settling ponds where gypsum solids are separated from the liquid.

". . . all in a Single SNRB™ Device"

Progressive Technology Exceeds Expectations

At the outset, it looked as though Babcock & Wilcox Company's "SOx NOx Rox Box™ (SNRB™) project had some pretty ambitious goals—to reduce SO_x by 70 to 90 percent, to reduce NO_x by more than 90 percent, and to reduce particulates to a level below the New Source Performance Standard of .03 lbs per million Btu. An even greater challenge was to do all of those things in a single SNRB™ device.

Today, months after testing first began, it looks like the SNRB™ has met its challenges and will turn out to be a viable and economic process. Moreover, during the project, other objectives beyond the original ones were identified and met, further enhancing the likelihood that this promising technology will reach its commercialization goals.

The SNRB™ demonstration facility is a 5-MW slipstream unit located at Ohio Edison's R.E. Burger Power Plant near Shadyside, OH. The essence of the demonstration is a single process unit—a high-temperature, pulse-jet baghouse. Because of the modular nature of the baghouse and the use of commercial-size filter bag/catalyst assemblies, the slipstream unit is considered large enough for commercial demonstration. Six modules, each containing 42, 6.25 inch by 20-foot commercial-size filter bags, make up the demonstration unit. Larger units will simply be made up of more modules, with each module having more bags of the same size.

In the SNRB™ emissions control system, a selective catalytic reduction (SCR) catalyst is mounted in catalyst retainers inside the individual filter bags. SO_2, sorbent and ammonia are injected into the flue gas upstream of the baghouse. The baghouse filter bags remove the spent sorbent and fly ash from the flue gas. Ammonia reacts with NO_x in the presence of the SCR catalyst to form N_2 and water. For optimal SO_2 and NO_x emissions control, the filter bags are made of high temperature fabrics such as woven ceramic fibers (Nextel™ manufactured by 3M) or woven glass fibers (Owens-Corning S2-Glass™).

The SCR catalyst is a zeolite-based NC-300™ series monolith catalyst manufactured by Norton Chemical Process Products. Because it is located inside (clean side) of the bags, the catalyst is not subject to either erosion by fly ash or chemical fouling by ammonium bisulfate. Another feature of the SNRB™ system is that the clean, hot flue gas, when returned to the boiler heat exchanger sequence, is nearly free of SO_2 and has a very low acid dewpoint. This allows the air heater to cool the flue gas to a much lower temperature than is normal practice, significantly enhancing the thermal efficiency of the boiler.

Early in the execution of the SNRB™ project, results from bench-scale $Ca(OH)_2$-SO_2 kinetics tests indicated that above a certain injection temperature, recarbonization of CaO occurred to such a degree that sorbent recycle was not practical. Even so, with once-through commercial-grade hydrated lime at Ca/S ratios of 1.8 to 2.0 and baghouse temperatures of 830 to 860°F, sulfur removals of nearly 90 percent were achieved. At this high-sulfur removal level, the lime utilization is about 45 percent, which is significantly higher than with other dry lime injection processes. And, somewhat surprisingly, the SO_2 capture tests showed that, in addition to the Ca/S ratio, a more significant variable for sulfur capture was not the injection temperature or the duct residence time, but rather the operating temperature of the baghouse. Injecting sorbent immediately upstream of the baghouse resulted in the best SO_2 capture results.

In addition to commercial-grade hydrated lime, Dravo Lime produced two other limes with modified hydration processes—the addition of sugar and calcium lignosulfonate to the hydrated water. Both removed more than 90 percent of the sulfur from flue gas at a 2.0 Ca/S ratio and a temperature of 850°F. A third sorbent, sodium bicarbonate ($NaHCO_3$), yielded sulfur removals of more than 80 percent at a Na_2/S ratio of 1.0 and a baghouse temperature of 450°F.

NO_x emission reductions were consistently above 90 percent, with an NH_3/NO_x ratio of 0.85 at baghouse temperatures of 800 to 850°F. The optimal operating temperature ranges when using lime are the same for SO_2 and NO_x reduction. Ammonia slip was routinely below 5 ppm. Ammonia concentration in the treated flue gas was monitored by EPA method 5 sampling and, periodically, by a continuous NH_3 analyzer.

Particulate emissions downstream of the baghouse averaged 0.018 pounds per million Btu, corresponding to a collection efficiency of 99.89 percent. Particulate loading at the baghouse inlet with lime injection was about three times that of fly ash alone. The particulate emissions did not vary significantly with air-to-cloth ratio, lime injection rate, baghouse pressure drop, bag cleaning efficiency, or the combination of baghouse modules in service.

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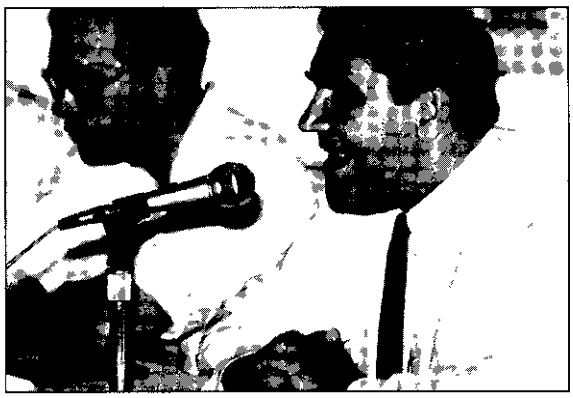
Promise of Coal Gasification Power Draws 400 Representatives to Wabash River Site

Construction of what will be the nation's largest coal gasification combined-cycle power plant was formally launched on July 7, when more than 400 government, utility, and energy representatives joined the news media at PSI Energy's Wabash River Generating Station near Terre Haute, Indiana.

The reason for the gathering was to commemorate the beginning of construction of the "Wabash River Coal Gasification Repowering Project," a project being overseen by a joint venture of PSI Energy Inc., of Plainfield, IN, and Destec Energy Inc., of Houston, Texas. DOE is providing half of the Round-IV project's $396 million total cost.

Highlighting the ceremony were keynote speeches by Indiana Congressman John Myers, PSI President and Chief Executive Officer James Rogers, Destec President and Chief Executive Officer Charles Goff, and Dr. C. Lowell Miller, DOE's Associate Deputy Assistant Secretary for Clean Coal Technology.

Following the speeches, General Richard Lawson, President of the National Coal Association, joined DOE, PSI and Destec representatives to field questions from the audience and news media.



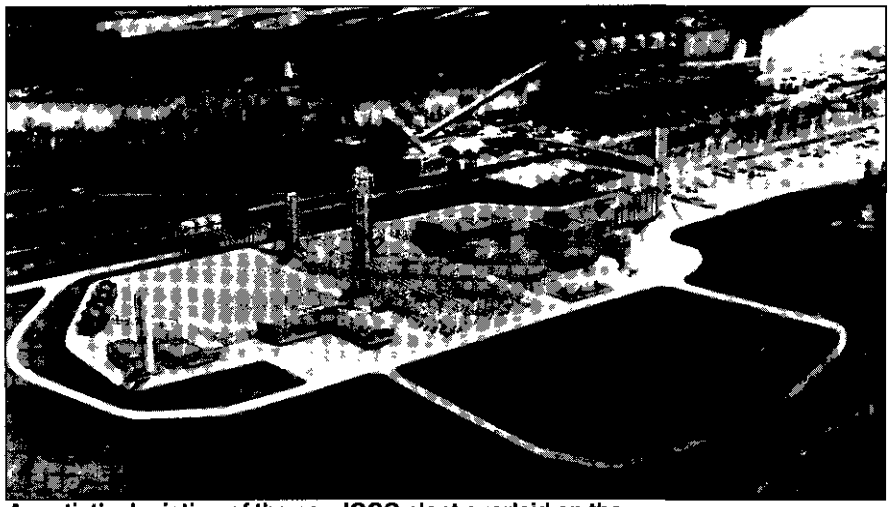
Destec Energy's Vice President Stephen C. Jenkins (left), and National Coal Association President Gen. Richard Lawson, field questions from the media at Wabash River's groundbreaking ceremony.

The project will demonstrate the 265-MWe repowering of an existing pulverized coal-based generating unit with Destec's oxygen-blown, entrained-flow coal gasification technology. Operation of the repowered plant is scheduled to begin in October 1995. Following a three-year demonstration, the plant is expected to continue in commercial operation for the next 22 years.

By the time of the groundbreaking ceremony, the project had cleared all environmental and regulatory hurdles needed to begin construction, including completion of DOE's National Environmental Policy Act process. After completing a detailed Environmental Assessment, DOE concluded that the project would not significantly affect the quality of the human environment and on May 28, 1993, issued a "Finding of No Significant Impact". A second milestone was achieved on May 27 when the Indiana Department of Environmental Management issued an air quality permit for the facility. Following a 33-day public comment period, the permit became final on June 29.

In the regulatory arena, the Indiana Utility Regulatory Commission issued Certificates of Public Convenience and Necessity on May 26. These certificates document PSI's need for additional power and evaluate the prudency of the choice of power generation technology.

Following site preparation work, actual construction will begin and is expected to be complete within two years. CCT



An artist's depiction of the new IGCC plant overlaid on the current site.

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Gypsum from the stack will be evaluated to determine if it can be used for marketable purposes. Four gypsum companies have expressed interest in wallboard evaluation, and the University of Georgia is already looking at gypsum potential for agricultural applications. Early tests seem to indicate that the gypsum will be a strong candidate for use as a soil ameliorant for several crops. The gypsum will also be evaluated for use in cement.

The CT-121 tests are also expected to show the CT-121's strong economic

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advantage. The variable operating cost of SO_2 removal, based on power consumption and limestone cost, is very low. The station service needed to run the CT-121 unit, originally estimated to be 1.5 percent of rated output, may actually decrease when process optimization is complete.

The demonstration at Plant Yates will evaluate several major cost-reducing features:

- *Use of fiberglass reinforced plastic (FRP)*, a strong, corrosion-resistant material that can be substituted for the stainless steel normally used to build scrubbers. The 42-foot diameter by 42-foot high reactor was manufactured on-site using a unique spinning process, and is the largest such unit to be manufactured on a job site in the United States. The wet flue gas ducts, the stack, and a 28-foot diameter, 25-foot high fiberglass limestone slurry tank are also made of this material.
- *No need for spare absorber modules* that are normally required to overcome reliability problems caused by corrosion, erosion, and operating problems associated with stainless steel construction. The JBR is so reliable that spare absorbers are not required.
- *No need for a flue gas reheat step.* Conventional systems require that the flue gas be reheated to avoid condensation on the downstream duct work and stack. In the Yates CT-121 demonstration, the cleaned flue gas leaving the JBR passes through two stages of mist eliminators to separate or remove the droplets of entrained moisture. Condensed droplets are then collected inside the FRP chimney by a static aerodynamic removal section. After these de-entrainment steps, the fallout of droplets from the stack plume is not detectable, even when the humidity of the surrounding air approaches 100 percent
- *Simultaneous removal of SO_2 and particulates.* Because of the excellent gas-liquid contact in the JBR, the CT-121 system is also able to capture particulates. This could be a major cost-saver especially for building new plants. CCT

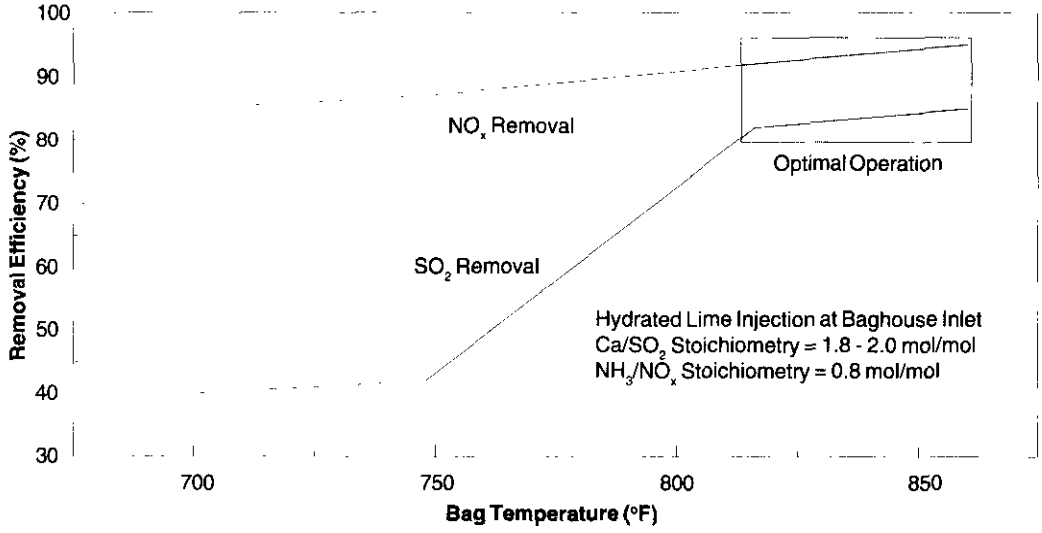
. . . "SNRB" from page 3

During the course of the project, two major challenges were added to the SNRB™ project. The first was endurance testing of high-temperature filter bag fabrics and testing of the ability of SNRB™ to control Hazardous Air Pollutants. Preliminary economic analyses suggests that filter bag selection could significantly affect the overall process economics. Three fabrics, Nextel™, S2-Glass™, and Silontex (also woven with glass fiber) were tested in a pilot pulse-jet baghouse at a utility site operating on a flyash-containing flue gas at process temperature. Both Nextel™ and S2-Glass™ maintained acceptable fabric strength over 3,800 hours of testing and were light enough for efficient pulsed-jet cleaning. S2-Glass™ was installed in one module of the demonstration unit toward the end of the project and performed well.

The second addition to the original project scope was to assess the ability of SNRB™ to control hazardous air pollutants, or air toxics. In April and May 1993, an air toxics measurement program sampled the inlet and outlet streams around the boiler, the SNRB™ system, and the electrostatic precipitator.

This Round II Clean Coal Technology demonstration project is now in the data analysis and reporting stage. All test work has been completed except for chemical analyses. Preliminary economic analyses indicate that this combined, three-pollutant control process will cost less than a combination of the three separate flue gas cleanup processes—wet scrubbing, SCR, and a pulse-jet baghouse. Industry and electric utilities are expected to commercialize the SNRB™ system as future emissions regulations and compliance strategies are finalized. CCT

SNRB™ Emission Reduction Performance



Clean Coal Program Marks First Commercial Success with Sale of Low NO_x Technology

The Clean Coal Technology Program recorded its first domestic commercial sale with the announcement that Allegheny Power System (APS) would purchase an advanced low-NO_x burner system from the Babcock & Wilcox Company (B&W).

The burners will be installed at one of APS's 555-MW coal-fired boilers at the Hatfield's Ferry plant near Masontown, PA. The plant is jointly owned by the three operating companies of APS and operated by West Penn Power Company headquartered in Greensburg, PA.

[The sale is the first in the U.S. to result directly from a successful demonstration project co-funded by government and industry in DOE's Clean Coal Technology Program. With 45 projects valued at more than $6.9 billion, the Clean Coal Technology program is the federal government's largest and only joint effort with industry to develop advanced, environmentally clean, energy technologies.]

The Low NO_x Cell™ technology was developed by B&W, in cooperation with the Electric Power Research Institute, specifically for certain coal-fired plants with "cell" burners. It was demonstrated and perfected at a 605-MW boiler at Dayton Power & Light's J.M. Stuart Station near Aberdeen, Ohio. The assistance and cooperation of Dayton P&L was a major factor in the successful conclusion of this project.

Cell burners, like those installed at the Stuart Station, were developed in the 1960s specifically to burn coal efficiently in a compactly designed utility boiler. The tight spacing of the combustion nozzles, however, makes the burners inherently higher emitters of NO_x than many other coal burners.

Today, boiler units representing more than 23,000 MW of generating capacity operate with cell-type burners. The 1990 Clean Air Act Amendments require that these plants cut their NO_x emissions by the year 2000 or sooner if the plant is located in an ozone nonattainment area.

Taking a moment to note the CCT program's first domestic sale are (left to right): Sam Esleeck, B&W's Washington Office; Dr. C. Lowell Miller, DOE's Clean Coal Office; Gene Michaud, B&W's Contract Research Division; and Jackie Bird of the Ohio Coal Development Office.

The Low NO_x Cell™ system is based on a "plug in" design that makes it attractive for retrofitting existing cell burner boilers. In cell-burner boilers, the system can be installed at about half the cost and outage time as other commercial low-NO_x burners. B&W expects to sell the burner retrofits for $5.5-$8 per kilowatt.

APS was one of several electric utilities which, along with Electric Power Research Institute and Dayton Power & Light, contributed funding to the Clean Coal Technology demonstration project. In return, the utility obtained first-hand knowledge of the new technology's performance; this performance convinced the utility to be the first commercial customer for the technology. Funding was also provided by the Ohio Coal Development Office.

The Stuart Station tests were the first full-scale demonstration of B&W's Low NO_x Cell™ burners. In the usual cell burner application, burners are closely coupled into cells of two or three burners with less than five feet of vertical spacing between them. In effect, each cell operates as a single unit. While this design provides high heat concentration and improved combustion efficiency, it also results in high levels of NO_x emissions.

Before the availability of B&W's Low NO_x Cell™ burner, reducing NO_x emissions from cell units involved additional and costly measures that also required long plant outage time.

The Low NO_x Cell™ burners limit NO_x emissions by "staging" the mixing of air with fuel during the combustion process. The top nozzle of the two-nozzle cell is replaced with an air port. This way, coal enters the boiler through the lower nozzle only. About 70 percent of the total air needed for complete combustion is supplied through or around this coal feed nozzle. The remaining air is directed to the upper air port, thus staging the air for each burner.

The Clean Coal Technology Program provided a means for not only testing

See "Sale" on page 8 . . .

". . . to provide maximum flexibility"

SCR Tests Progress at Gulf's Plant Crist

Tests are now under way that will help determine if selective catalytic reduction (SCR) technology—already in widespread use overseas—can be effective on U.S. power plants that burn high-sulfur coal. Startup and shakedown of a new SCR demonstration facility, located at Gulf Power's Plant Crist near Pensacola, FL, was completed in June and a two-year operating and testing period began on July 1.

SCR technology is a post-combustion technique that has the potential to cut NO_x emissions by as much as 90 percent. Such a high NO_x reduction technology may be needed for coal-burning power plants located within ozone nonattainment areas, including a 16-state area in the northeastern United States.

But while SCR with natural gas, oil and low-sulfur coal combustion fuels has been widely used in Japan and Western Europe, it is not yet known whether this technique can be effective—or economical—on high-sulfur U.S. coals in the U.S. utility environment. This multi-pronged Clean Coal Technology project was designed for the most thorough technical and economic evaluation ever made of SCR on high-sulfur U.S. coals.

The SCR test facility was also designed to provide maximum flexibility. It uses flue gas from the station's 75 MW Unit 5, which burns U.S. coals with sulfur contents of nearly three percent. The facility is made up of nine separate reactor systems—three of which treat the equivalent of 2.5 MW of flue gas and six smaller units that each treat the equivalent of 0.2 MW.

With SCR technology, ammonia is injected into the hot flue gas as it leaves the economizer section of the boiler. Injection takes place far enough upstream of the SCR reactor so that the ammonia completely mixes with the flue gas. As the gas passes through a fixed bed of catalyst in the reactor, NO_x formed during combustion reacts with ammonia to form elemental nitrogen and water vapor. The amount of ammonia used can be adjusted to achieve the desired degree of reaction for NO_x reduction.

The test program was designed to address the key uncertainties associated with the use of SCR technology operating with high-sulfur coals. For example, there are trace elements in many U.S. coals that are not found, or are only found in much lower concentrations, in other coals. These elements may have the effect of poisoning and degrading the SCR catalyst. Another concern is that the presence of high amounts of SO_2 and SO_3 resulting from combustion of high-sulfur coals may lead to plugging of downstream equipment with ammonia-sulfur compounds.

Another objective of the tests is to determine the performance and optimum operating conditions of a variety of SCR catalysts made of different compositions, geometries, and manufacturing methods. A total of nine commercial catalysts will be tested from three U.S., two European, and two Japanese vendors. The three U.S. firms will provide five of the catalysts, with the remaining firms providing one each.

Both parametric and steady-state tests will be conducted, with a parametric test matrix repeated every three months on each reactor train. Once a parametric test matrix is completed, the reactor will be returned to baseline design conditions for three months of steady-state operations to test for aging of the catalyst. For each catalyst, data will be collected on $deNO_x$ efficiency, pressure drop, oxidation of SO_2 to SO_3, and ammonia slip.

Before the beginning of each parametric test, a catalyst sample will be given to its supplier for laboratory analyses. A common testing protocol was established with all of the vendors to assure consistent and accurate testing analyses. The deactivation rates and lives of the catalysts will be determined by observing $deNO_x$ efficiency during the steady-state operating periods between parametric tests.

Air preheaters will be incorporated into the project to evaluate the effects of

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The botton of the SCR reaction facility showing the three cyclones used to collect ash after the flue gas passes through the reactors seen above.

. . . "Briefs" from page 1

Edison's Niles station. About 120 people gathered at the site each day. The project continues to more than meet its goals of 95 percent SO_2 removal, 90 percent NO_x reduction, and production of a high purity sulfuric acid. After more than 4,500 hours of operation to date, 2,700 tons of acid have been produced and sold. Tests under the DOE project will end in November, but ABB/CE and Ohio Edison are discussing ways to continue the project as a "showcase" once the testing is completed.

The Ohio Coal Development Office is looking for projects which focus on the clean use of Ohio coals in the deployment of a cost-effective clean coal technology at full-scale for final testing and long-term application. Commercial, industrial, or utility-scale projects are eligible for funding, and cost-sharing is expected. Proposals are due by December 31, 1993. To obtain a copy of the solicitation, call the Ohio Coal Development Office at (614) 466-3465.

On the heels of the noteworthy 16-day test reported in the last issue of *Clean Coal Today*, the **ENCOAL** Mild Gasification demonstration plant in Gillette, WY logged another 12-day run in June. The plant reached 100 percent of design capacity for a short period during the run, which ended in a planned shutdown. The plant is now undergoing a major modification in preparation for extended operations this fall....The pioneering plant attracted an important international visitor when the Indonesian Ambassador to the United States visited ENCOAL on June 23. Indonesia has large reserves of coals comparable in quality to those being used as feedstocks at ENCOAL.

Ohio Power's **Tidd Pressurized Fluidized Bed Combustion** plant is up and running again following a five-month hiatus to make repairs to the gas turbine. In mid-February, two low-pressure blades had broken during routine operation at the Brilliant, Ohio, plant. The most recent test-run began on July 18 and clocked more than 400 hours before coming down for a brief outage after which operation resumed. The 70-MW plant has accumulated a total of 4,100 hours of coal-fired operation, including approximately 1,100 hours of slipstream operation with a hot gas ceramic filter.

In June, DOE agreed to the request of **York County Energy Partners** to move their planned 250-MW demonstration of circulating fluidized bed combustion technology to a new site at the P.H. Glatfelter paper mill in Spring Grove, PA. The new combustion unit will replace a 1950s vintage boiler, offering a two-to-one reduction in SO_2 emissions from the site. DOE conducted a scoping meeting on the environmental impacts of the project at the new site on August 19. Nearly 60 speakers provided comments at the meeting, which was attended by some 275 interested people. Due to high local interest, a continuation of the scoping meeting is scheduled for October 5, 1993 in York, PA.

In other news, **Union Carbide** withdrew its proposal for a 75-MW demonstration of the **CANSOLV™** technology at Alcoa's Warrick Generating Station in Indiana. Union Carbide told DOE that it could not find a financial partner for the project, a partner made necessary after an internal Union Carbide reshuffling took place after the project was selected. DOE was to have paid half of the project's $38 million total cost. CCT

. . . "Sale" from page 6

the Low NO_x Cell™ burner at a commercial scale, but also optimizing its design.

During the demonstration program, B&W engineers redesigned the burner impellers (the devices positioned at the nozzle outlets to control flame geometry) to make them more effective in reducing NO_x emissions. The engineers also found that reversing the air ports with the coal nozzle in selected burners would result in more complete combustion and prevent potentially corrosive gases (hydrogen sulfide and carbon monoxide) from accumulating in the lower portion of the furnace.

With these design changes in place, NO_x emissions reduction improved to more than 55 percent without impairing boiler performance—more than meeting the project's 50 percent NO_x reduction goal. Carbon monoxide concentrations in the lower furnace were consistently held at very low levels, well within acceptable limits.

The modifications made by B&W during the test program showed the benefit of the federally co-sponsored Clean Coal Technology Demonstration Program. Only at full-scale did the need for design changes become apparent. Federal cost-sharing provided participants with the financial flexibility to "debug" and improve the technology before it reached the commercial marketplace.

Other participants in the $11 million project were the Tennessee Valley Authority, New England Power Company, Duke Power Company, Cincinnati Gas & Electric, Columbus Southern Power Company, and Centerior Energy Company. CCT

. . . "SCR" from page 7

deposit formation from SCR reaction chemistry upon the airheater's performance.

Testing will take place over the next two years. The project final report will include an evaluation of the SCR process' economics. The $23.3 million project was selected in the Round II of the Clean Coal Technology Demonstration Program. CCT

Status of Clean Coal Technology Demonstration Projects

American Electric Power. Tidd PFBC Demonstration Project. (Brilliant, OH)
More than 600 hours of testing have been logged since the turbine was returned to operation in late June. Parametric testing is under way to collect data on sulfur capture efficiencies, paste quality, and use of limestone as a sorbent in lieu of dolomite. To date, the plant has accumulated a total of 4,100 hours on coal, including 1,100 hours of operation with hot particle filters on a slipstream.

CQ, Inc. Coal Quality Expert. (Homer City, PA)
All six field tests were completed in late-April, with the sixth and final test at Brayton Point, Massachusetts. A fully functional Coal Quality Expert prototype that will predict the impact of coal quality upon boiler operations, maintenance, bus bar costs, and emissions is scheduled for completion by the end of 1993.

EER Corporation. Enhancing the Use of Coal by Gas Reburning and Sorbent Injection. (Hennepin and Springfield, IL)
Illinois Power has decided to retain the Gas Reburning system and sorbent silo at Hennepin for possible use in 1995 for NO_x control. Work continues on the report of the results of long-term testing. At the Lakeside Station of City Water, Light & Power in Springfield, IL, preliminary results of short-term testing of Sorbent Injection without Gas Reburning has indicated that the goal of a 50% SO_2 reduction can be achieved. Gas Reburning operation started in June 1993, and initial operation indicates the system operates as designed.

Rosebud Syncoal Partnership. Advanced Coal Conversion Process Demonstration (Colstrip, MT)
Phase III Operations which started in June 1992, are continuing. Modifications were made to the demonstration facility to overcome earlier operating difficulties.

York County Energy Partners. Circulating Fluidized Bed Cogeneration Project. (North Codorus Township, PA)
DOE approved a request by the Participant to move the project approximately 6 miles from West Manchester to North Codorus Township, Pennsylvania. At the new site, the plant would continue to generate electricity for sale to Metropolitan Edison, while providing steam to the adjacent P.E. Glatfelter paper mill. A public scoping meeting focusing on the new site was held on August 19.

ABB Combustion Engineering. IGCC Repowering Project. (Springfield, IL)
Efforts continue to address the high capital cost projection for the project.

ABB Combustion Engineering. SNOX Flue Gas Cleanup Project. (Niles, OH)
The project continues to operate smoothly in meeting or exceeding the goal of 95% SO_2 removal and reduction of over 90% of NO_x emissions while producing a high purity sulfuric acid. The unit has accumulated over 4,500 hours of operation, and 2,700 tons of acid have been sold. The test period is expected to end in November 1993.

American Electric Power Service Corp. PFBC Utility Demonstration Project. (New Haven, WV)
Value engineering activities are continuing to refine the preliminary design for a 340-MW greenfield plant.

Babcock & Wilcox. Coal Reburning for NO_x Control. (Cassville, WI)
Results of parametric and optimization testing with bituminous coal indicate that NO_x emissions are reduced by about 55 percent between full load (110 MW) and 70 MW. From 70 to 40 MW the NO_x reductions range from 50 to 35 percent. Results of reburn testing on western coal appear to be better than those obtained on bituminous coal. All testing, including air toxics emissions testing, is complete for this project.

Babcock & Wilcox. SNRB Flue Gas Clean-Up Project. (Dilles Bottom, OH)
This project is now in the data analysis and reporting stage. All test work has been completed except for chemical analysis. Preliminary economic analyses indicate that this combined, three-pollutant control process will cost less than a combination of the three separate flue gas clean-up processes—wet scrubbing, SCR and pulse-jet baghouse.

Bethlehem Steel Corp. Blast Furnace Granulated Coal Injection. (Burns Harbor, IN)
The Environmental Assessment has been completed and DOE has issued a Finding of No Significant Impact. The Participant recently completed all of the contractual, permitting and financing arrangements needed to move into the construction phase of the project.

Bethlehem Steel Corp. Coke Oven Gas Cleaning System. (Sparrows Point, MD)
The coke ovens were placed on "cold idle" on January 24, 1992. The project has been postponed for at least two years to allow for rehabilitation of the coke ovens.

Passamaquoddy Tribe. Cement Kiln Flue Gas Recovery Scrubber. (Thomaston, ME)
Installation of a new chevron-style mist eliminator system has been completed and the scrubber is operating.

Pure Air. Advanced Flue Gas Desulfurization Demonstration Project. (Chesterton, IN)
The FGD scrubber is operating and has demonstrated the capability to reduce SO_2 emissions by greater than 95 percent, thereby removing some 60,000 tons of SO_2 on an annual basis. Byproduct gypsum is 97 percent pure and is being sold to U.S. Gypsum. Tests with 3.5-4 percent sulfur coal have been completed. Smooth operations are continuing.

Southern Co. Services. Chiyoda Thoroughbred 121 FGD Process. (Newnan, GA)
Preliminary results of long term testing which began in March 1993, substantiated results achieved during earlier parametric testing, with SO_2 removal reaching a high of 98.7 percent. Particulate removal was greater than 99 percent and the limestone utilization rate is about 97 percent. Since the project came on line in October 1992, the scrubber has recorded 98 percent reliability and availability indices while logging over 5,000 hours of operation.

Southern Co. Services. NO_x Reduction for Tangential-Fired Boilers. (Lynn Haven, FL)
Long-term test data from operating the Low NO_x Concentric Firing System Level I, II, and III equipment (three basic air/coal feed configurations tested) indicated full load NO_x reductions up to 37, 40, and 48 percent, respectively, compared to the baseline emission

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data. A report is being prepared on the completed air toxics testing. Additional Level III tests have shown that increasing the fineness of the fuel significantly reduces the unburned carbon levels of the flyash with little or no effect on NO_x emissions.

Southern Co. Services. NO_x Reduction for Wall-Fired Boilers. (Coosa, GA)

Long-term testing of the Advanced Over Fire Air (AOFA) and for the Low-NO_x Burners (LNB) has been completed. Chemical emissions testing was completed in May 1993. Low-NO_x digital control system preliminary engineering is complete. Testing of the LNB plus AOFA configuration is scheduled to continue until the planned September 1993 outage.

Southern Co. Services. SCR for High-Sulfur Coal Boilers. (Pensacola, FL)

The nine reactor SCR facility start-up and shakedown were completed in June 1993. Catalyst loading was completed in late June 1993. Test operations are now in progress.

Air Products and Chemicals, Inc. Liquid Phase Methanol Process. (Daggett, CA)

Given the state of the economy in California and availability and price forecasts for natural gas, the Texaco Cool-Water project with the Liquid Phase Methanol unit is no longer competitive. DOE is currently reviewing an alternative site plan submitted by Air Products and Chemicals, Inc.

AirPol, Inc. Gas Suspension Absorption Project. (Paducah, KY)

Preliminary test results of the Gas Suspension Absorption (GSA) system concluded that the GSA is capable of achieving 99+ percent SO_2 removal. The second half of the test program is in progress. Testing of the 1 MWe pulse jet baghouse is being conducted concurrently with the GSA tests.

Alaska Industrial Development Authority. Healy Clean Coal Project. (Healy, AK)

Engineering and permitting efforts are proceeding. TRW completed combustor design verification testing in March, successfully firing a full-scale pre-combustor module using a newly designed coal feed system.

Babcock & Wilcox. Low-NO_x Cell™ Burner Retrofit. (Aberdeen, OH)

Optimization testing was completed in July 1992; long term baseline testing is complete. NO_x emission reductions exceeded the 50 percent target level.

Bechtel Corp. Confined Zone Dispersion FGD Project. (Indiana County, PA)

Parametric testing using type S, pressurized dolomitic lime slurry injection indicates that SO_2 removals near 50% can be achieved. The 6-month continuous run has encountered problems associated with the slurry injection nozzles. DOE is discussing possible solutions with Bechtel and Penelec.

DMEC-1 Ltd. Partnership. Pressurized Circulating Fluidized Bed Demonstration Project. (Pleasant Hill, IA)

Preliminary design is continuing. An Implementation Plan for completion of the Environmental Impact Statement has been approved and a draft Environmental Impact Statement has been prepared for review.

EER Corp. Gas Reburning and Low-NO_x Burners on a Wall-Fired Boiler. (Denver, CO)

The Gas Reburn system continues to operate in automatic load following mode with preliminary results indicating the 70% NO_x removal goal can be achieved.

ENCOAL Corp. Mild Gasification Project. (Gillette, WY)

More than 5,000 tons of Powder River Basin coal were processed during the May 1993 run, which produced in excess of 125,000 gallons of liquid fuel and several thousand tons of solid product. Another successful test was completed in June 1993, demonstrating the operation of the plant at 100 percent of design feed rate. To date, 15 test runs have been completed, representing nearly 1,800 hours of operation on coal. The plant will be shut down until September 1993, to complete a major plant modification to the solids cooling system.

LIFAC N. America. LIFAC Sorbent Injection Desulfurization Demonstration Project. (Richmond, IN)

Parametric testing began in February 1993. Increased opacity levels as a result of LIFAC operation have caused some delay in parametric testing.

MK-Ferguson Co. NOXSO Flue Gas Cleanup System. (Niles, OH)

Preliminary design activities continue. The design is now incorporating the results of pilot testing. In July 1993, NOXSO announced that the demonstration would not proceed at the planned Niles, OH site. The sponsors are evaluating the possibility of an alternate site.

Public Service Co. of CO. Integrated Dry NO_x/SO_2 Emissions Control System. (Denver, CO)

Low NO_x burner and overfire air testing results indicate NO_x removals between 60 and 69 percent. On-site testing for Baseline Air Toxics Monitoring, and testing of the urea and aqueous ammonia injection system have been completed. At full load, 43 percent reduction was achieved with a 10 ppm ammonia slip. Initial injection of calcium hydroxide into the fabric dust collector inlet duct with humidification to an approach temperature of 30 °F gave an SO_2 reduction of 20 to 30 percent. Preliminary results of calcium hydroxide injection into the economizer with humidification gave less SO_2 removal. Testing will be completed in mid-1994.

Tampa Electric. Integrated Gasification Combined Cycle Project. (Tampa, FL)

A detailed cost estimate for the plant has been completed. A first draft of the Environmental Impact Statement has been completed and comments have been returned to the Environmental Protection Agency (the Lead Agency for the EIS). The Participant is discussing with the Florida Department of Environmental Resources the operating permits required for demonstration and post-demonstration operation. A hearing on the permits is scheduled for September.

Custom Coals International. Self Scrubbing Coal: An Integrated Approach to Clean Air. (Greensboro, PA; Springdale, PA; Richmond, IN)

Project definition activities are continuing. Preliminary design of the coal cleaning plant is more than 50 percent complete.

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New York State Electric and Gas (NYSEG). Milliken Clean Coal Technology Demonstration Project. (Lansing, NY)
Design activities are underway. The Environmental Assessment activities continue and are expected to be completed in the near future.

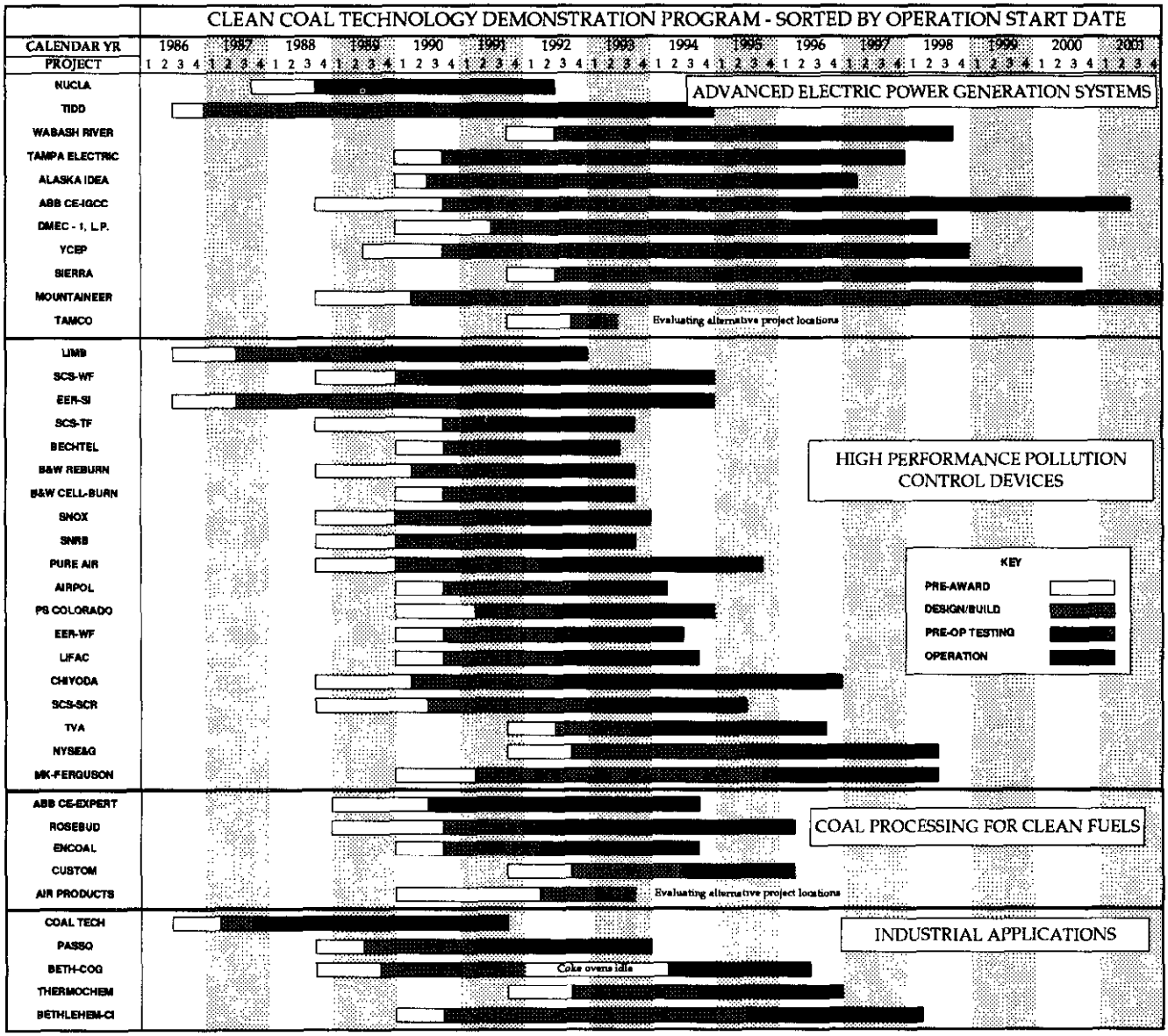
TAMCO Power Partners. Toms Creek IGCC Demonstration Project. (Coeburn, VA)
Project definition and preliminary design activities are under way. A power purchase agreement is being sought.

Tennessee Valley Authority. Micronized Coal Reburning for NO_x Control. (Paducah, KY)
Design and construction are expected to overlap for a short period, with construction being essentially completed this winter.

ThermoChem, Inc. Demonstration of Pulse Combustion in an Application for Steam Gasification of Coal. (Gillette, WY)
A preliminary design of the ThermoChem coal gasification demonstration plant integrated with the host K-Fuel facility was completed in April 1993. Environmental information is being prepared for use in the NEPA process. Test gasification of the design coal is underway at ThermoChem's Baltimore, MD facility.

Sierra Pacific Power. Piñon Pine IGCC Project. (Reno, NV)
DOE has approved use of a newly introduced GE Model 6FA gas turbine on the project. The project will represent the first commercial application for this new high-efficiency, high firing temperature turbine. Environmental engineering activities are being conducted in support of project permitting requirements and preparation of an Environmental Impact Statement. Hearings on Sierra Pacific's Resource Plan are being conducted by the Public Service Commission of Nevada.

Wabash River Joint Venture. Wabash River Coal Gasification Repowering Project. (W. Terre Haute, IN)
The participant hosted a media event at the project site on July 7, 1993, to mark the beginning of project construction. See article in this issue of Clean Coal Today *for details.*



Upcoming Events

Date	Event	Contact
October 24-28	***5th International Conference on Processing and Utilization of High Sulfur Coals,*** Lexington Hyatt Regency, Lexington, KY.	Teresa Epperson (606) 257-0305
November 3	***Seminar: Advanced Coal Preparation Techniques for Utilizing Waste Coal Fines,*** Stone Crab Inn, St. Clairsville, OH	Randy Pennington (301) 903-3485
November 30-December 3	***IEA Second International Conference on the Clean & Efficient Use of Coal: Its Role in Energy, Environment and Life,*** The J.W. Marriott Hotel, Hong Kong.	Barbara McKee (301) 903-4497

CCT Reports Update

The following Clean Coal Technology Program Reports and Comprehensive Reports to Congress have been released since the last issue of *Clean Coal Today*. Copies of the reports are available from the National Technical Information Services, U.S. Department of Commerce, Springfield, VA 22161.

October 1992	DOE/PC/90544-T6	*Healy Clean Coal Project: Healy FCM Testing at Niro Air Pollution Pilot Facility*
May 1993	DOE/PC/79799-TL	*The Coal Tech. Advanced Cyclone Combustor Demonstration Project - A DOE Assessment*
July 1993	DE-FC22-91PC905443	*Healy Clean Coal Project, Design Verification and Cold-Flow Modeling Test Report*

The following papers, authored by DOE employees or CCT participants, have been delivered at recent conferences. Copies are available from the authors. For further information, contact Doug Archer, Office of Clean Coal Technology, at (301) 903-9443.

"Application of an Advanced Power System in the Tampa Electric Polk Power IGCC Project." Donald E. Pless, TECO Power Services; and Gregory J. Starheim, GE Power Generation; *PowerGen '93 Conference,* Paris, France, May 1993.

"Combining Low-NOx Burners, Overfire Air, and SNCR for High Efficiency NOx Removal." T. Hunt and R. Smith: *Air & Waste Management Association's 8? Annual Meeting & Exhibition,* Denver, CO, June 13-18, 1993.

"The Effects of Low NO_x Combustion on Unburned Carbon Levels in Wall Fired Boilers." John N. Sorge, R.R. Hardman, S.H. Wilson, and L.L. Smith; *Engineering Foundation Conference on Coal Utilization,* February 1993.

"The ENCOAL Project: Status of the Plant and Product Testing." Thomas G. McCord and James P. Frederick, ENCOAL Corporation; and Walter F. Farmayan, Shell Development Corporation; *Seventeenth Biennial Low-Rank Fuels Symposium,* St. Louis, MO, May 1993.

"Flue Gas Desulfurization as High Sulfur Coals Retrofit Costs, Lime Consumption and Removal Efficiencies 10 MWe DOE Demonstration Plant." Willard L. Goss; *Coal Utilization & Fuel Systems Conference,* April 1993.

"Low-NO_x Combustion Modifications for Down-Fired Pulverized Coal Boilers." E. Mail, and others: *American Power Conference,* Chicago, IL, April 13-15, 1993.

"Operating Costs for the 110 MWe Nucla CFB." M. Friedman, R. Divilio, Combustion Systems, Inc.; J. Buck and S. Bush, Tri-State Generation & Transmission Association, Inc.; and N. Rekos, U.S. Department of Energy; *12th International Conference on Fluidized Bed Combustion,* San Diego, CA, May 1993.

"A Programmatic Look at the Role of Fluidized Bed Technology in the Clean Coal Technology Program," D. Huber, Burns and Roe Enterprises Inc., and J. Geffken, U.S. Department of Energy; *12th International Conference on Fluidized Bed Combustion,* San Diego, CA, May 1993.

"Pure Air's FGD Facility at Northern Indiana's Bailly Generating Station Cited as an Outstanding 1992 U.S. Engineering Achievement." Greta Campbell; *National Society of Professional Engineers (NSPE's) 27th Annual Outstanding Engineering Achievement Awards Competition,* January 1993.

"Reducing Stack Emissions by Gas Firing in Coal-Designed Boilers—Field Evaluation Results." B. Folson, C. Wong, I. Sommer, and J.M. Pratapas; Presented at the *EPRI/EPA Joint Symposium on Stationary Combustion NO_x Control,* Miami Beach, FL, May 1993.

"Summary of Air Toxics Monitoring Activities Being Sponsored by DOE's Clean Coal Technology Demonstration Program." Thomas A. Sarkus and Richard A. Hargis; Presented at *Managing Hazardous Air Pollutants 2nd International Conference,* Sponsored by Electric Power Research Institute, Washington, DC, July 1993.

"Test for an Optimization Method Applied to Controlling NO_x Emissions in a PC-Fired Boiler." J.J. Catasus-Servia, R.T. Squires, R.A. Smoak, A.L. Baldwin, and J.N. Sorge; Presented at the *3rd International Joint ISA/POWID EPRI Controls and Instrumentation Conference,* Phoenix, AZ, June 1993.

"Test Results from the 70 MW Tidd PFBC Demonstration Plant." M. Mudd, D. Hafer, and M. Zando, American Electric Power Service Corporation; *12th International Conference on Fluidized Bed Combustion,* San Diego, CA, May 1993.