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INNOVATIVE CLEAN COAL TECHNOLOGIES (ICCT)

DEMONSTRATION OF INNOVATIVE APPLICATIONS OF TECHNOLOGY FOR COST REDUCTIONS TO THE CT-121 FGD PROCESS

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Section 1

SUMMARY

The objective of this project is to demonstrate several innovative applications of cost-reducing technology to the Chiyoda Thoroughbred-121 (CT-121) process on a commercial scale. CT-121 is a third generation flue gas desulfurization (FGD) process which is considered by the Electric Power Research Institute (EPRI) and Southern Company Services (SCS) to be one of the most reliable and lowest cost FGD options for high-sulfur coal-fired utility boiler applications. Demonstrations of the following innovative design approaches will further reduce the cost and provide a clear advantage to CT-121 relative to competing technologies:

- use of fiberglass reinforced plastic (FRP) to construct the absorber vessel, wet ducts, and chimney (stack),
- elimination of flue gas reheat,
- elimination of the need for a spare absorber, and
- use of a single vessel for simultaneous particulate and SO_2 removal.

The demonstration will be performed at Georgia Power Company's Plant Yates Unit No. 1 (100 MW capacity) near Newnan, Georgia. The project will be funded by the U. S. Department of Energy (DOE), SCS (on behalf of the entire Southern electric system), and EPRI. SCS is the participant responsible for managing all aspects of this project.

The project is being conducted in the following three phases:

Phase I - Permitting and Preliminary Engineering;
Phase II - Detailed Design, Construction, and Startup; and
Phase III - Operations, Testing, and Disposition.

In Phase I, permitting activities were initiated by both SCS and Georgia Power to obtain air, water and gypsum disposal permits with all applications necessary for the Yates Project submitted. The Environmental Monitoring Plan has also been completed and submitted to DOE for review. Two sets of groundwater samples were obtained from the gypsum stack site, and environmental reporting activities were initiated. Approval of the gypsum stack Design & Operating (D&O) Plan submitted last year was approved this quarter. For Phase II, the system design basis document was completed which outlines important process decisions made during preliminary engineering. Detailed engineering activities concluded this quarter and construction continued its rapid pace.

Section 2

INTRODUCTION

The Innovative Clean Coal Technology (ICCT) Program is designed to demonstrate clean coal technologies that are capable of retrofitting or repowering existing facilities to achieve efficiency improvements and/or significant emissions reduction, specifically in sulfur dioxide (SO_2) and/or nitrogen oxides (NOx) emissions. The technologies selected for demonstration on the Southern electric system are capable of being commercialized in the 1990s and are expected to be more cost effective than other current technologies.

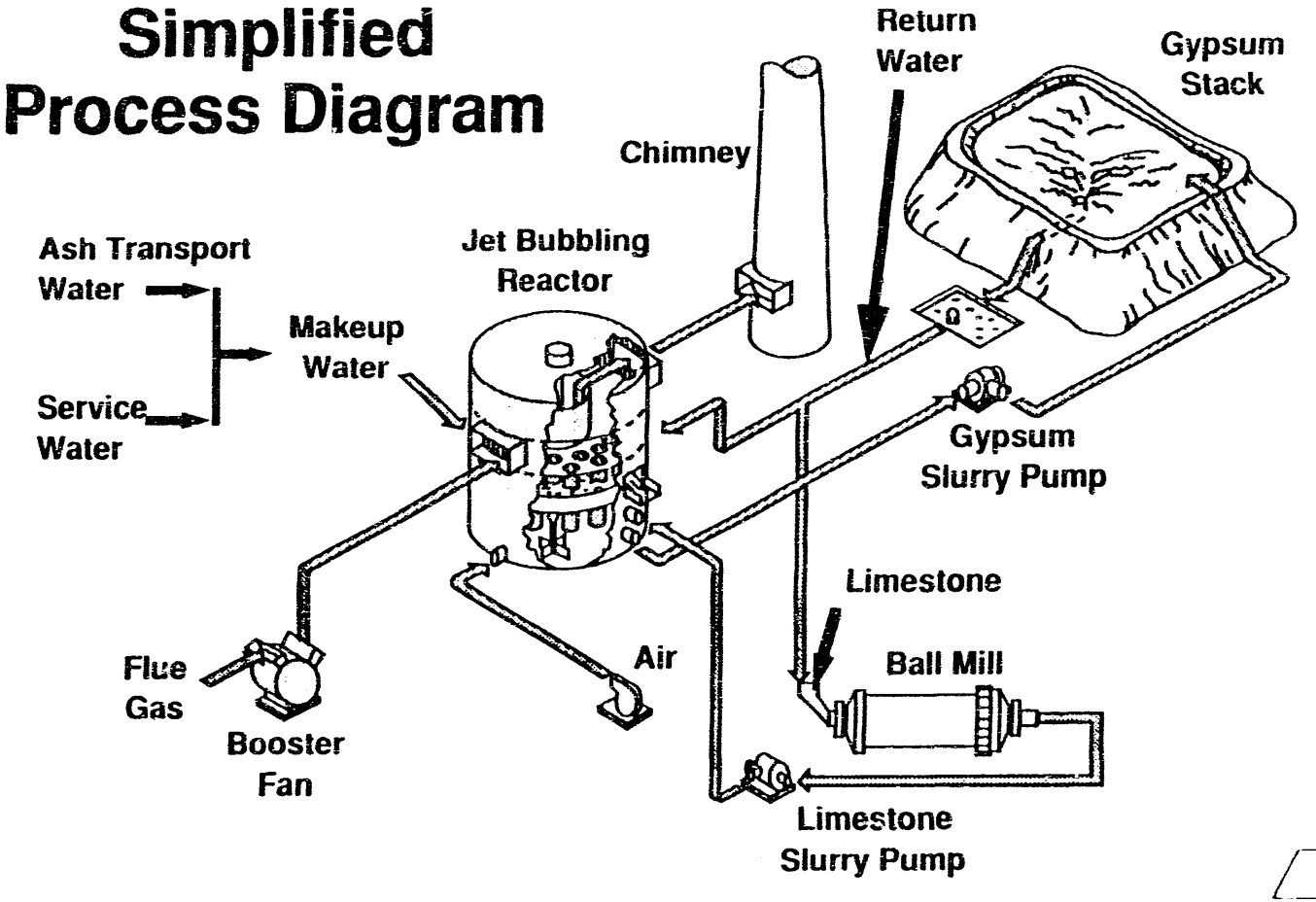
The Yates ICCT project is jointly funded by the U.S. Department of Energy (DOE), the Electric Power Research Institute (EPRI), and Southern Company Services (SCS) on behalf of the entire Southern electric system. The project's objective is to demonstrate innovative applications of technology for cost reduction for the Chiyoda Thoroughbred-121 (CT-121) process. The CT-121 process is a third generation flue gas desulfurization (FGD) process that EPRI and SCS consider to be one of the least cost FGD processes in its current commercial configuration as evidenced in recent EPRI work (GS-7193, Economic Evaluations of FGD Systems, 1991). Further cost reductions will only make this process even more competitive and more attractive to electric utilities.

The CT-121 process is a wet FGD process that removes SO_2, can achieve simultaneous particulate control, and can produce a salable by-product gypsum thereby reducing or even eliminating solid waste disposal problems. Figure 1 shows a flow schematic of the process. CT-121 removes SO_2 and particulate matter in a unique limestone-based scrubber called the Jet Bubbling Reactor (JBR). In the JBR, flue gas bubbles beneath the slurry, SO_2 is absorbed, and particulate matter is removed from the gas. The agitator circulates limestone slurry to ensure that fresh reactant is always available both in the liquid reservoir and the bubbling or froth zone so that SO_2 removal can proceed at a rapid rate. Air is introduced into the bottom of the JBR to oxidize the absorbed SO_2 to sulfate, and limestone is added continuously to neutralize the acidic intermediate products. The JBR is designed to allow ample time for complete reaction of the limestone, for complete oxidation of the SO_2, and for the growth of large gypsum crystals. The gypsum slurry is continuously withdrawn from the JBR and is to be dewatered by sedimentation in a gypsum stack. The stacking technique involves filling a diked area with gypsum slurry, allowing the gypsum solids to settle, and removing clear liquid from the top of the stack for recycle back to the process.

The CT-121 process is in widespread commercial use in Japan and at one location in the United States. None to date, are completely comparable to a coal-fired utility application. At the University of Illinois, a 45 MW CT-121 process constructed of FRP began operations in 1988 on a stoker boiler, used for campus heating. In Japan, commercial CT-121 processes are used to treat the flue gas from boilers which burn oil or low-sulfur coal. Some of the oil-fired units do not include particulate control devices upstream of the CT-121 processes, another atypical application.

Figure 1

Simplified Process Diagram



The purpose of the Yates ICCT project is to demonstrate the process on high-ash/high-sulfur U.S. coal using several design modifications that may reduce the estimated cost of the present CT-121 process by 23 percent for power plant retrofit applications and up to 50 percent for new power plant installations. This will be accomplished while maintaining 90 percent SO_2 removal and high particulate removal efficiency. A reusable gypsum byproduct will also be produced during the project.

The major cost-reducing design changes to be demonstrated are:

- using less expensive materials of construction (FRP),
- eliminating a spare absorber module,
- eliminating flue gas reheat, and
- combining SO_2 and particulate removal in a single vessel.

Utility scale units with the CT-121 processes currently include a prescrubber for control of soluble chloride concentrations and use JBRs made of stainless steel, which is relatively expensive. Typically, outlet ducts are lined or made of alloys, and the chimney is likewise lined. Failures are common. Liners normally have to be replaced after a period of time which adds additional expense and inconvenience. For this demonstration project at Yates, the JBR, inlet duct, and chimney will be made of solid fiberglass-reinforced plastic (FRP) which is unaffected by chlorides or other corrosion mechanisms normally experienced in FGD processes. A successful demonstration of FRP in this project will confirm that a prescrubber is not needed in the CT-121 process and will also demonstrate a JBR construction material which is less expensive than stainless steel.

This project is also intended to demonstrate that the CT-121 process using a JBR made of FRP is highly reliable and does not require a spare absorber module to maintain this reliability. Current Federal New Source Performance Standards (NSPS) require that spare scrubbers be installed on utility FGD systems if scrubber bypass options are to be utilized (spare absorber must be put into service and also fail before bypass is authorized). Scrubbers retrofit for compliance with the Clean Air Act Amendments of 1990 will not need an option to bypass, however, so single module installations become more attractive.

Another cost-saving modification to be demonstrated in this project is the elimination of flue gas reheat downstream of the scrubber. The flue gas leaving any wet scrubber is at its water dewpoint. Without reheat, subsequent cooling and depressurization in the downstream ductwork and stack causes moisture to condense into small droplets. These water droplets absorb traces of SO_2 and form highly acidic droplets that cause severe corrosion in downstream metals. In addition, these droplets may be carried out of the stack by the gas velocity to fall nearby (or "rain out"), causing damage to surrounding structures and vehicles. To prevent these problems, this project will use operating techniques and uniquely designed equipment that will "knock out" the droplets, drain them to the JBR for neutralization and eliminate the need for reheating.

The final cost-saving experiment will be the testing of simultaneous SO_2 and particulate matter removal in the JBR. Typically, an electrostatic precipitator or fabric filter is used on coal-generated fluegases to remove particulate matter. In the CT-121 process, greater than 90 percent of the SO_2 and 99 percent of the particulate matter in the entering flue gas can be removed in the JBR as a result of the torturous path taken by the flue gas, the significant pressure drop and the extended gas/liquid contact time. When used in new power plants, eliminating the ESP or fabric filter could result in substantial cost reductions in both capital and operating expenses. Thus, the CT-121 process provides a cost effective alternative to conventional wet FGD systems that could eliminate the need for a separate particulate collection device as well.

This project will be performed at Georgia Power Company's Plant Yates, Unit No. 1, located about 40 miles southwest of Atlanta between Newnan and Carrollton. The CT-121 process to be installed for this demonstration project will treat the whole flue gas stream generated by the 100 MW Unit 1 boiler. The coal to be burned during the project will be a blend of Illinois #5 and #6 coals and will contain between 2.5 and 3 percent sulfur coal.

The demonstration project will be conducted over an 81-month period with project activities including environmental monitoring, permitting, design, construction, operation, process evaluation, and gypsum by-product evaluation. The project is organized into three phases: (1) Phase I - Permitting and Preliminary Engineering; (2) Phase II - Detailed Engineering, Construction, and Startup; and (3) Phase III - Operation, Testing, and Disposition. Phase I is scheduled for 8 months, Phase II is scheduled for 27 months with a six-month overlap with Phase I, and Phase III is scheduled for 52 months. Operations are planned for 24 months with the remainder of Phase III activities dedicated to gypsum byproduct utilization and gypsum stack groundwater monitoring studies. The cooperative agreement was signed April 2, 1990, and the project completion date is projected to be mid-1996. The total estimated project costs are $35,843,678. The co-funders are SCS ($11,297,032), DOE ($17,546,646), and EPRI ($7,000,000).

Section 3

PROJECT DESCRIPTION

Within the three phases of the project, the following tasks will be conducted to effectively demonstrate a reduced-cost CT-121 process:

Phase I - Permitting and Preliminary Engineering

- Task 1 - Development of Environmental Monitoring Program
- Task 2 - Permitting Activities
- Task 3 - Preliminary Engineering
- Task 4 - Gypsum Stack Site Characterization and Groundwater Well Siting Activities
- Task 5 - Process Engineering Support
- Task 6 - Georgia Power Engineering Coordination
- Task 7 - Project Management and Reporting
- Task 8 - Preliminary Gypsum Stacking and Byproduct Studies

Phase II - Detailed Design, Construction, and Startup

- Task 1 - Detailed Design Engineering
- Task 2 - Process Engineering Support
- Task 3 - Georgia Power Engineering Coordination
- Task 4 - Construction
- Task 5 - Test Plan Development
- Task 6 - Training of Operations and Maintenance Personnel
- Task 7 - Startup
- Task 8 - Baseline Groundwater Monitoring
- Task 9 - Environmental Data Management and Reporting
- Task 10 - Project Management and Reporting
- Task 11 - Phase II Gypsum Stack Design and Byproduct Studies

Phase III - Operations, Testing, and Disposition

- Task 1 - Operations and Maintenance
- Task 2 - Process Evaluation
- Task 3 - Gypsum Stacking and Byproduct Evaluation
- Task 4 - Groundwater Monitoring
- Task 5 - Environmental Data Management and Reporting
- Task 6 - Economic Analysis
- Task 7 - Disposition
- Task 8 - Project Management and Reporting

Section 4

PROJECT STATUS

Progress during the January - March 1992 quarter is summarized below. Activities continued in the environmental and engineering tasks while construction activities are complete on major pieces of equipment.

PHASE I - PERMITTING AND PRELIMINARY ENGINEERING

Task 1 - Development of Environmental Monitoring Program

The Environmental Monitoring Plan was completed by Radian, reviewed by SCS, and submitted to DOE during the last quarter of 1990. This plan includes a quality assurance/quality control plan and sampling and analyses procedures manual.

Task 2 - Permitting Activities

The permits required for the project are in four categories: (1) those required during mechanical construction, (2) an air permit required for operation, (3) water permits for operation of the process / wet stacking area and (4) two solid waste handling permits: one for construction of the gypsum stack and one for its operation after certification of construction in accordance with the approved D&O Plan. Georgia Power and SCS have completed efforts in all but the last area which awaits the completion of the gypsum stacking area. Previously, Georgia Power obtained permission to conduct fiberglass manufacturing operations at Plant Yates. The air permit has been approved by the state and the FAA has waived any requirement for aviation markers on the FRP chimney. This quarter, the state finally approved the (D&O Plan) for the gypsum stack that was submitted the second quarter of 1991 and construction resumed.

Task 3 - Preliminary Engineering and
Task 5 - Process Engineering Support

Conceptual process engineering concluded this period. Most process decisions had been made during previous meetings and correspondence with Chiyoda-Japan. Representatives from Chiyoda visited Yates in June, November and December of 1991 for additional discussions of the SCS concept and examination of the JBR. However, changes in process values continue for describing control span and operational set points now that the control system has been setup and connected at the site. Chiyoda supplied draft Operating Instructions this quarter which are out for comment. A review meeting on site to finalize documentation is scheduled for late next quarter (June 1992).

Task 4 - Gypsum Stack Site Characterization and Groundwater Well Siting Activities

Activities to support the gypsum stack permitting effort were completed during the January-March, 1992 quarter. Initial ground clearing was started in September, 1991 but halted in October 1991 due to the lack of progress on the permit application. Two additional wells were dug in response to the Georgia Geological Survey in December 1991. The impact on baseline data from these two wells will have to be addressed in future reporting of analytical results due to their delayed installation. Construction at the gypsum stacking area was resumed this quarter and is scheduled for completion in July 1992. (see Task 2 above).

Task 6 - Georgia Power Engineering Coordination

Phase I activities in this area have been completed. Similar coordination activities are being continued in Phase II.

Task 7 - Project Management and Reporting

These activities have been completed for Phase I. Similar activities continue in Phase II.

Task 8 - Preliminary Gypsum Stacking and Byproduct Studies

The activities in Phase I have been completed. Additional work is continuing in Phase II as originally proposed. There is also the consideration of providing large quantities of gypsum to several wallboard manufacturers and a cement manufacturer. This would require additional equipment for gypsum washing and is an unfunded, optional activity presently under consideration. A proposal for this additional scope is being drafted and will be offered to both EPRI and the DOE.

PHASE II - DETAILED DESIGN, CONSTRUCTION, AND STARTUP

Task 1 - Detailed Engineering,
Task 2 - Process Engineering Support, and
Task 3 - Georgia Power Engineering Coordination

The engineering schedule continues to be highly integrated with a number of activities close to the critical path. Late in 1991, the decision was made to formally delay the scheduled startup as a result of the uncertainty in the gypsum stacking permit. However, the continued absence of a permit for the gypsum stacking area has delayed start-up until after the peak summer demand period as tie-in during the June-August time period can not be guaranteed. Weekly meetings were held at SCS-Birmingham between Civil, Electrical, I&C, Mechanical, and Process Engineering disciplines to facilitate communications.

Weekly conference calls were also held with the Construction Manager and the SCS Project Manager visited the site at least weekly. Monthly project review meetings have been held at Plant Yates regularly. Weekly Start-Up Team meetings began in August, 1991. DynaGen completed flow modeling work to design liquid collectors for wet duct and chimney operation. These collectors are being installed this quarter. The scale model will be maintained intact at DynaGen in the event additional questions arise from operational observations in Phase III.

Task 4 - Construction

Construction site activities were at a peak during this quarter and will begin to taper off in the next quarter. Georgia Power's completion list includes all foundations, the control building, sumps, ductwork and insulation, inlet spray section, slurry tank, wash water tank, ball mill, fan and limestone conveyor system. The control room building has been completed and was energized this quarter. An application to the State for a potable water addition to this structure has not been approved, however. The Bailey Network 90 Control system experienced more software inconsistencies early in the quarter but these have been resolved. The Bailey system was shipped from the SCS instruments lab to the site control building this quarter. Power-up is expected next quarter. Ershigs has finished work on JBR internals and reworked the floor of the JBR to remove some objectionable pin-type fasteners (Georgia Power construction restriction). Although Ershigs formally demobilized this quarter, they returned later to add abrasion-resistant resins layers on the vessel floors underneath the agitators in the JBR and the limestone slurry tank as well as to repair baffle delaminations that occurred during the acoustics testing. This return work by Ershigs is still underway. Another FRP contractor, Composite Construction & Engineering (CCE), was tasked to add the droplet elimination structures in the chimney elbow suggested by DynaGen's study of the exit (cleaned) gas flow patterns. A final video on this flow study will be delivered next quarter as will Physical Acoustics' final report on their baseline testing of the JBR and limestone slurry tank.

Late this quarter, the D&O plan for construction of the gypsum stacking area was approved by the State of Georgia and work resumed after a 30 day appeal period passed. Weather has intermittently hampered progress here, however. Electrical cable and control line pulls are still underway. The inlet ductwork (carbon steel) is complete and insulated. The mist eliminator wallpapering is now complete and 100% seam-leak tested. Erection of the mist eliminator blade wash system is underway. Construction continues with the addition of control and power wiring, the sealing of sumps and piping runs.

Task 8 - Baseline Groundwater Monitoring

All baseline sampling has been completed on the five original wells with the collection of the last set of samples in July, 1991. Review of the project monitoring plan for the operating period is underway by the Georgia Geological Survey and two additional wells were sited and installed in the fourth quarter of 1991 at their suggestion. A written report will be prepared describing results, however, initial analysis indicates good agreement between laboratories and no significant anomalies in measured parameters noted.

Task 10 - Project Management and Reporting

The management information system continues to be used to control budget and schedule and to help fulfill DOE reporting requirements. Monthly and quarterly reports have been submitted. Weekly meeting were held between lead engineers and construction management. Monthly site review meetings were also conducted. Visitors to the site have been numerous including congressional staff, DOE management, Public Service Commission staff from Alabama and Georgia and representatives from Chiyoda-Japan. A briefing to the DOE staff in Pittsburgh was accomplished early this quarter.

Task 11 - Phase II Gypsum Stack Design and Byproduct Studies

Two of the three steps in obtaining a permit for the gypsum stacking area were completed without significant difficulty - - zoning approval from Coweta County and site acceptability approval from the Georgia Geological Survey. The last step proved more difficult - - approval of the Design & Operating Plan (D&O Plan) by the Georgia Environmental Protection Division (EPD). Using design information from Ardaman on the gypsum stacking area, the D&O Plan was submitted last year and approved this quarter. After a 30 day appeal period passed, work resumed at the gypsum stacking area with Ardaman certifying that construction will meet the approved permit requirements. The University of Georgia has continued its limited, preliminary investigation and screening of plants which might be candidates for gypsum stack revegetation and for crop yield experiments after process startup. Also, four wallboard manufacturers and a cement manufacturer have agreed to participate in laboratory and manufacturing evaluations of Yates FGD gypsum. Test plan arrangements are currently under

negotiations. All four wallboard manufacturers have indicated that the Yates material will probably be too high in 'as-is' moisture and chloride content for immediate use. Therefore, SCS and Georgia Power are presently investigating the requirements for gypsum dewatering and washing prior to shipment for possible expansion of the project's scope.

PHASE III - OPERATIONS, TESTING and DISPOSITION

Not yet underway, begins with system operations. However, preparations for Phase III are underway such as operator training, set-up of the laboratory and work on both the operating instruction and the test plan.

Section 5
PLANNED ACTIVITIES

During the April - May 1992 quarter, the following activities are planned:

- Review of the Operator Training Plan, the Start-Up Plan and the Operating Test Plan.
- Power-up and checkout of the Bailey process control system.
- Completion of the additional FRP work by Ershigs and Composite Construction and Engineering (CCE).
- Continuation of all construction activities to keep the project on schedule.
- Continuation of intensive work on the gypsum stacking area.
- Tie-in of scrubber ductwork during scheduled Unit #1 outage in May.
- Site visits by the Southern States Energy Board's Clean Coal Coordinating Committee and the Electric Power Research Institute's FGD Chemistry Advisory Committee.
- The second Project Review meeting is scheduled.
- Continuation of all environmental, project management, and reporting activities.

END

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