TEST PLAN REVISION

As a result of technical and cost evaluations in this period, a decision has been made to redirect a portion of the experimental program. The 8/94 Phase II Test Plan included the following experimental tasks: 1) Reburn development at a scale of 15 million Btu/hr, at the University of Utah; 2) Large burner testing at 100 million Btu/hr, slag tap firing with reburning, at the DB Riley Research Center; 3) Bench-scale copper oxide tests at Tecogen; 4) Copper oxide moving-bed reactor testing at 5 million Btu/hr, at the Illinois Coal Development Park (ICDP); and 5) Copper oxide reactor testing on a 30 million Btu/hr (approximately 3 MW<sub>e</sub> equivalent) slip stream at the DB Riley Research Center.

A design for the 30 million Btu/hr copper oxide slipstream was completed in sufficient detail for cost and schedule quotations on major components. Both cost and construction time estimates were significantly higher than planned, a major factor being foundation and structural requirements specific to the available site. A further technical consideration was the limited, continuous test time available, due to operating restrictions, relative to the solids residence time within the reactor.

Therefore, our technical approach is revised as follows:

- Eliminate the 30 million Btu/hr slipstream copper oxide tests planned for Phase II.
- Redirect the resources planned for this test to expand the scope and duration of the tests at ICDP. This will allow us to accumulate longer operating time, on the full adsorption/regeneration cycle, necessary to evaluate process performance.

The chemistry and sorbent development/sorbent performance are not scale dependent. Process performance scale up can be evaluated using the comprehensive model and physical data being developed in Phase II. The major issue which may require additional scale up testing prior to the construction of the POC plant is the mechanical design and operation of the moving bed contactor. The resources available from the elimination of the Phase II 30 million Btu/hr scale tests will permit us to do the following:

- Under Phase III, with the Phase II results from model development and tests at ICDP in hand, prepare a detailed design for a 3-5 MW<sub>e</sub> equivalent copper oxide test. Several options are currently being evaluated; the most promising is an expansion of the facility at the Illinois Coal Development Park.
- Immediately on authorization of Phase IV, construct the test unit, and operate it to generate the required scale-up information for use in the detailed design of the POC unit.
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TECHNICAL PROGRESS

Copper Oxide Process FGD.

**ICDP Facility Construction.** The evaluation of alternate siting locations within the Illinois Coal Development Park (ICDP) complex was completed, and fixing the location at the east side of the High Bay Facility adjacent to the existing flue gas treatment equipment. The duct and damper for temperature control of flue gas entering the CuO adsorber from the existing firetube boiler were fabricated, and connection to boiler commenced. Bucket elevators, a vibrating screen/feeder, the regenerator, and lock hoppers were ordered and received on site in the reporting period. Arrangements for foundation and structural steel installation were completed. A planning meeting at Illinois Coal Development Park (ICDP) was held to discuss manpower requirements and updated schedule.

**Sorbent and Process Model Development.** Data reduction was completed for the 1/4” and 1/8” sorbent material, including a preliminary comparison of adsorber size and performance for the two sizes using the process model. This helped to identify additional data, tests, and model modifications required to complete the particle size comparison for the adsorber. The computer model of the adsorber was modified to include the kinetic model.

A second substrate in 1/4” and 1/8” sizes was evaluated using the tube furnace. In addition, a sample of the original 1/16” sorbent was evaluated to provide comparative data for the size comparison. Previously generated data were reevaluated to determine kinetic rate parameters.

The methodology for implementing a combined reaction-diffusion adsorption model was finalized. The tube furnace data were regressed based on this model, and the kinetic parameters were updated. A model was developed for heat of adsorption. A variable-voidage pressure drop model was developed for the case of mixed full-size and broken (attritted) sorbent.

The 30 million Btu/hr test facility for copper oxide tests has been eliminated from Phase II as discussed above. However, in this period, the final designs of all major components already developed for this system were incorporated into plan and elevation drawings. The drawings and a description of the design methodology will be assembled as a topical report for future reference.

**Firing System**

**Computational Modeling.** Models of unstaged and staged operation of a full scale U-fired unit were completed. For the air staging case, the predicted level of NOx at the combustion zone outlet was highly dependent on the wall condition assumed for the walls downstream of the slag screen. For slagging walls downstream of the screen (the chamber walls upstream of the screen are always assumed to be slagging), the predicted NOx was about 760 ppm, whereas for clean walls, the predicted level was 360 ppm. The field results were approximately 600 ppm for the case on which the model was based. Without air staging, the model predicted approximately 1400 ppm NOx for slagging downstream walls, comparing well with the field observation of 1350 ppm. These models reflect the air staging actually retrofit to a U-fired boiler. The retrofit did not include either advanced low-NOx burners or reburning.

Modeling also continued in support of the designs for both the L1500 test unit and the 100 million Btu/hr combustion chamber. Modeling was specifically aimed at mixing of reburn and staging streams in the L1500, as well as to evaluate the effects of multiple burner operation on the creation of stratified flows in the L1500. Stratified flow will be created intentionally in order to physically simulate the flow in a full scale system.
Model runs were used to validate the refractory specification in the 100 million Btu/hr unit. As with the commercial units of this design, the 100 million Btu/hr combustion chamber refractory design depends upon an insulating layer of solid slag over a relatively thin layer of conductive refractory. The model simulations indicated that ash deposition rates should be sufficiently high to develop such a layer in the order of ten hours of operation.

**Combustion Tests, 15 Million Btu/hr Scale.** Most support systems (lighting, electricity, water) are functional. Concrete support foundations for the natural gas meter, primary air blower, sewer, and water systems are complete. Initial design evaluations for the control system were completed.

The primary task in this period was installation of refractory in the furnace sections, which was completed in this period. Flue gas piping was received and installed. The scrubber and ID fan were erected, and will be connected into the system next period. The control room is about 40% complete.

**Combustion Tests, 100 Million Btu/hr Scale.** All major component mechanical designs have been completed. Foundations, flue gas breeching, air ducts, and structural steel were released for fabrication. The foundation, including piles, grade beams and slab, was completed. Refractory design for the flue gas breeching was finalized and an order released to the vendor. Evaluation of refractory design for the combustor proper continued.

Construction of the slagging combustor modules continued. The combustor is being fabricated in a “front half” (down fired section) and “back half” (up flow section) in order to maintain a size shippable by truck. The front half was completed in December, with shipment delayed until January due to holidays and weather. The refractory anchor studs will be installed on combustor interior walls after delivery to the Worcester site. A preliminary list of instrumentation and connections to existing data acquisition system was developed.

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