FINAL TECHNICAL REPORT
September 1, 2002, through December 31, 2003

Project Title: **COMMERCIALIZATION OF FIRED BRICKS WITH FLY ASH FROM ILLINOIS COALS**

ICCI Project Number:	02-1/3.1A-3
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ABSTRACT

The goal of this project was to develop commercially viable fired bricks made with fly ash which could provide an alternative use for millions of tons of Illinois coal fly ash that is currently ponded or landfilled. The development and marketing of commercial fly ash-containing bricks would benefit the Illinois coal industry, utilities, and brick manufacturers by converting fly ash now being discarded into an economical ingredient for brick-making in Illinois. Industrial participants included Colonial Brick Company, Richards Brick Company, Streator Brick Company, Ameren Energy Fuels and Services Company, and Dynegy Midwest Generation, Inc. This report covers Phase IV, the last of a four-phase investigation. The Phase IV objectives were to optimize the in-plant firing parameters, maximize fly ash substitution, update economic and environmental feasibility assessments, and help utilities and brick producers establish an agreement for producing fly ash bricks commercially.

During Phase IV, six commercial-scale production demonstration runs were conducted at three different brick plants. The extrusion parameters for producing three-hole and ten-hole building bricks at two Illinois-based companies and zero-hole commercial-size paving brick at one Indiana-based company were established. All of the green bricks, containing up to 40 wt% Illinois coal fly ash balanced with the conventional raw material of each brick company, were extruded successfully. Scaled-up firing tests were conducted to establish the procedures for a firing system at each brick plant. The type of brick (10-hole, 3-hole, zero-hole paving brick), variety of kiln (beehive or tunnel), and the amount of fly ash substituted must all be considered when optimizing the firing conditions to produce high-quality fired bricks with a successful yield. A combined total of more than 15,000 commercial-size fired bricks were produced for evaluation. The building bricks and the paving bricks that were successfully produced met ASTM standard specifications. An Illinois-based brick company, together with an utility company, is working toward building a new brick plant near a utility plant to produce commercial bricks using Illinois coal fly ash.

Pages 1 to 20 contain proprietary information.

EXECUTIVE SUMMARY

Each year over 3,000,000 tons of fly ash are produced from the combustion of Illinois coal. Nearly all of this waste is discarded in landfills and ponds. The goal of this project was to develop a commercially viable product that could provide an alternative use of this waste fly ash. Through the joint efforts of the Illinois State Geological Survey (ISGS)/ University of Illinois (UIUC), and industrial partners, including but not limited to, Colonial Brick Company (CBC), Streator Brick Company (SBC), Richards Brick Company (RBC), Ameren Energy Fuels and Services Company (Ameren), and Dynegy Midwest Generation Inc. (DMG), a process of successfully producing fired bricks that contain some fly ash in place of the traditional raw materials was developed. Under the right conditions, production of bricks containing Illinois coal fly ash can be commercially viable.

This report covers the last phase of this four-phase project. Phase I (1999-2000) focused on assessing the technical feasibility of producing fly ash-containing bricks in a clay-rich formulation. In Phase I, more than 380 bar-size (1" x 1" x 4") test bricks were produced. The amount of fly-ash in clay-rich formulations was maximized and additives to improve the appearance and strength of the bricks were investigated. Test bricks produced with clay-rich formulations with amounts of fly-ash ranging from 20 to 70 wt% met commercial specifications, and showed greater fired compressive strength and heat insulation capability than a conventional brick made without ash.

Phase II (2000-2001) focused on pilot plant production tests and extended small-scale testing to evaluate fly ash containing bricks with shale-rich (more shale than clay) formulations. The tests were also expanded to include not only dry fly ash samples obtained from an electrostatic precipitator, but also wet samples collected from impoundment ponds. (Few utilities are planning to install a dry ash-collection system in the near future.) During Phase II, about 600 full-size (modular, 7.625" x 3.625" x 2.25") test bricks with 50 wt% fly ash were produced from two pilot plant runs and more than 340 bar-size test bricks were produced for evaluation. The small test bricks produced showed good commercialization potential. Phase II concluded with another successful pilot plant test run and produced 300 full-size bricks with 40 wt% of Illinois coal fly ash.

Phase III (2001-2002) focused on commercial-scale production demonstrations, economic evaluation, and commercialization of the technology. As a precursor to commercial-scale production, more than two hundred full-size green bricks were made at the ISGS laboratory. These green bricks, produced with several combinations of clay/shale and fly ash mixes, were used for firing at various brick production facilities. The preliminary firing results obtained were used to guide the commercial-scale firing tests. In addition to a commercial-scale run with standard raw material, five commercial-scale production tests (2,000 bricks per batch) with amounts of fly ash substitution ranging from 20 to 40 vol% (about 38 wt%) were conducted at an Indiana-based brick company. The characteristics of the bricks produced in the commercial-scale tests were consistent with those of the laboratory test bricks. The bricks produced with and without fly ash met or exceeded specifications for commercial face bricks.

During Phase IV, covered by this report, the objectives were:

1) to optimize plant firing parameters to consistently produce high-quality fired bricks, while maximizing fly ash substitution,

2) to evaluate new raw materials, including fly ash from utilities located near brick plants, for face and paving brick production,

3) to update the economic and environmental feasibility assessments of the final products, and

4) to help utilities and brick producers establish agreements for commercial production of fly-ash bricks.

During Phase IV, six commercial-scale production runs of 1,400 to 7,000 bricks per batch were conducted at three different brick plants. As a precursor to each commercial-scale production test, many preliminary in-plant firing tests were conducted using full-size green bricks made at the ISGS laboratory facility. These full-size green bricks were made with fly ash from four different sources at 10, 20, 30, 40, and 50 wt% fractions balanced with the conventional raw materials of each subject brick plant. More than eighty full-size green bricks were made from fly ashes supplied by the Edwards, Meredosia, Vermilion, and Wood River power plants in Illinois. The raw material compositions and firing parameters at each brick company that produced the highest quality fired bricks were used for commercial-scale production demonstrations.

From the commercial-scale production test runs, the extrusion parameters for producing three-hole and ten-hole building bricks at two Illinois-based companies and paving brick at one Indiana-based company were established. All the green bricks, containing up to 40 wt% Illinois coal fly ash and balanced with conventional raw material of each brick company, were extruded successfully. Scaled-up firing tests were conducted to establish the parameters for the specific firing system at each brick plant. The type of brick (10-hole, 3-hole, paving brick), variety of kiln (beehive or tunnel), and the amount of fly ash substituted must all be considered when optimizing the firing condition to produce high-quality fired bricks within a maximum successful yield. More than 15,000 commercial-size fired bricks were produced for evaluation. The building bricks and paving bricks that were successfully produced met ASTM standard specifications.

This project was successfully completed. The results indicated that the production of high-quality fired bricks relies not only on the sources and properties of fly ash and clay/shale materials, but also on the operational parameters of the brick plant. Feasibility evaluations should be conducted on a case-by-case basis. An Illinois-based brick company, together with an utility company, is working toward building a new brick plant near a utility plant to produce fly ash bricks in Illinois.

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