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**Disposal of Fluidized Bed Combustion Ash in an
Underground Mine to Control Acid Mine Drainage and
Subsidence**

**Quarterly Report
December 1, 1996 - February 28, 1997**

Work Performed Under Contract No.: DE-FC21-94MC29244

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Project - ETD05 "Disposal of Fluidized Bed Combustion Ash in an Underground Mine to Control Acid Mine Drainage and Subsidence"

EXECUTIVE SUMMARY

This project will evaluate the technical, economic and environmental feasibility of filling abandoned underground mine voids with alkaline, advanced coal combustion wastes (Fluidized Bed Combustion -FBC ash). Success will be measured in terms of technical feasibility of the approach (i.e. % void filling), cost, environmental benefits (acid mine drainage and subsidence control) and environmental impacts (noxious ion release).

Phase I of the project was completed in September 1995 and was concerned with the development of the grout and a series of predictive models. These models were verified through the Phase II field phase and will be further verified in the large scale field demonstration of Phase III. The verification will allow the results to be packaged in such a way that the technology can be easily adapted to different site conditions. Phase II was successfully completed with 1000 cubic yards of grout being injected into Anker Energy's Fairfax mine. The grout flowed over 600 feet from a single injection borehole. The grout achieved a compressive strength of over 1000 psi (twice the level that is needed to guarantee subsidence control). Phase III is to take 26 months and will be a full scale test at Anker's eleven acre Longridge mine site.

It is expected that the FBC ash will replace what is now an acid mine pool with alkaline solid so that the groundwater will tend to flow around and through the pillars rather than through the previously mined areas. The project has demonstrated that FBC ash can be successfully disposed in underground mines. Additionally, the project is directed towards showing that such disposal can lead to reduction or elimination of environmental problems associated with underground mining such as acid mine drainage and subsidence.

During Phase III the majority of the activity involves completing two full scale demonstration projects. The eleven acre Longridge mine in Preston County will be filled with 53,000 cubic yards of grout during the summer of 1997 and monitored for following year. The second demonstration involves stowing 2000 tons of ash into an abandoned mine to demonstrate the newly redesigned Burnett Ejector. This

demonstration is anticipated to take place during Summer 1997, as well.

This document will report on progress made during Phase III. The report will be divided into four major sections. The first will be the Hydraulic Injection component. This section of the report will report on progress and milestones associated with the grouting activities of the project. The Phase III tasks of Economic Analysis and Regulatory Analysis will be covered under this section. The second component is Pneumatic Injection. This section reports on progress made towards completing the demonstration project. The Water Quality component involves background monitoring of water quality and precipitation at the Phase III (Longridge) mine site. The last component involves evaluating the migration of contaminants through the grouted mine. A computer model has been developed in earlier phases and will model the flow of water in and around the grouted Longridge mine. The Gantt Chart on the following page details progress by task.

A. Hydraulic Injection

1.0 Task Description:

Task 11 - Hydraulic Injection: The purpose of this task is to grout the eleven acre Longridge mine with a grout consisting of coal combustion byproducts.

Task 12 - Economic Analysis: Burnett Engineering, Inc. shall develop economic analyses to compare the cost associated with disposal of coal ash in landfills with disposal of coal ash in underground mines to control subsidence and acid mine drainage.

Landfill disposal of MEA AFBC Power Plant ash. Burnett Engineering, Inc. shall develop an economic analysis for disposing of MEA AFBC ash in a landfill located near the Fairfax and Longridge mines. Costs to be included in the economic analysis include, but are not limited to, loading of ash at the power plant, transportation to the disposal site, landfill construction, landfill operation, landfill maintenance, and regulatory compliance. In addition, long-term cost impact on property values shall be estimated.

Landfill disposal practices of Northeast utilities. Burnett Engineering, Inc. shall use published data from the Electric Power Research Institute, and data from Monongahela Power Company and Allegheny Power Company to generate a range of cost estimates for disposing power plant ash in landfills. Burnett Engineering, Inc. shall describe the similarities and differences in ash disposal practices and costs for three utilities. Description of the similarities and differences shall include, but is not limited to, regulatory environment, environmental protection features in landfill design (e.g., liners), monitoring requirements, transportation, and ash handling.

Underground coal mine disposal of MEA AFBC Power Plant ash. Burnett Engineering, Inc. shall develop an economic analysis for disposing of MEA AFBC ash in the Longridge coal mine. Costs to be included in the economic analysis include, but are not limited to, loading of ash at the power plant, transportation to the disposal site, production of grout, injection of grout, mine maintenance, and regulatory compliance.

Burnett Engineering, Inc. shall analyze the costs associated with the benefits of underground mine disposal of the MEA AFBC Power Plant ash. These benefits include, but are not limited to, lower quantities of waste to be placed in the landfill, reduction in land subsidence, and improvements in water quality.

Task 13 - Water Quality Model: WVU shall use existing water quality model(s) or modifications of existing water quality model(s) to estimate the impact of ash disposal in underground mines on the concentrations of contaminants in nearby surface and ground water. Data from a geographical information system (GIS)

shall be coupled with the water quality model results to estimate the impact of disposal of MEA AFBC ash in the Longridge mine on concentrations of contaminants in nearby surface and ground water.

Task 14 - Regulatory Analysis: WVU shall review existing Federal, State of West Virginia, and local regulations and policies which could impact the disposal of ash from advanced coal combustion technologies in underground mines. The contractor shall identify any regulatory barriers to the widespread adoption of this disposal practice in West Virginia.

2.0 Summary of Accomplishments

2.1 A paper was given at the American Coal Ash Associations 12th International Ash Symposium in Orlando, Florida. Results of the project to date were presented.

2.2 Numeric Modeling of Phase III operations commenced.

2.3 Regulatory Analysis task was started but no results to date.

3.0 To-Date Accomplishments

Successfully completed Phase II grout injection.

4.0 Technical Progress Report

All work performed during this period consists of planning for Phase III demonstration project. WVU has acquired a computer code to model the Phase III grout injection. More information will be given in next quarters report as to progress on all tasks.

5.0 Plans for Next Quarter

5.1 Finalize NEPA documentation with U.S. DOE.

5.2 Coordinate Phase III injection with coal company personnel.

5.3 Continue with numeric modeling of grouting operations.

B. Pneumatic Injection

1.0 Task Description

The purpose of this task is to inject coal combustion byproducts into an underground mine via the Burnett Ejector. A complete economic analysis will be completed on the feasibility of this method of injection. Two thousand tons of ash are scheduled to be injected.

2.0 Summary of Accomplishments & Significant Events

A camera was purchased and will be mounted to aid in the aiming of the camera in the mine void.

3.0 To Date Accomplishments

Redesigned and manufactured pneumatic ejector.

4.0 Technical Progress Report

All work this quarter was devoted to selecting an injection site. Several candidate mines have been indentified. A site will be chosen based on several factors. The first being surface access. A mine site that has an open field above it would be ideal for moving of equipment and ease of drilling beorholes into the mine void. The second factor is the length and slope of the mine void. A mine with long, straight and relatively flat mine void is most desirable. The third factor to consider is water. The injection needs to take place in a mine that is dry. The ejector will not work under water. Given these considerations a mine will chosen and access gained through an agreement with the owner. Currently two mine sites are candidates. Both are owned by Anker Energy and are located near the Phase III Longridge site. The candidate sites are Decondor Mine and Squires Creek.

5.0 Plans for next Quarter

5.1 Select mine site and gain access through an agreement with owner.

5.2 Install camera and test in low light environment.

C. Water Quality Monitoring

1.0 Task Description

Baseline Water Quality Monitoring

The purpose of this task is to monitor the baseline water quality of the acid mine drainage (AMD) from the Longridge and Fairfax Mines prior to and during grouting. A flow monitoring and sampling station has been set up at the Longridge mine and a precipitation gauge has been established between the two mines.

2.0 Summary of Period's Accomplishments & Significant Events

Water quality monitoring and sampling continued as planned. Data is presented and discussed in some detail below for the reporting period of approximately three months. Flow from the Longridge Mine was consistent at around 50 gallons per minute. Acid loading ranged from 322 lbs/day to 425 lbs/day.

Sampling from the well located below the Fairfax Mine coal seam was conducted. Data is presented below.

3.0 Accomplishments to Date

Accomplishments to date include choice of parameters to sample, design of the sampling station, procurement of equipment, site preparation, installation and shake down of equipment, initiation of sampling and data analysis.

4.0 Technical Progress Report

Table 1 displays the water quality data collected from the Longridge mine. Flows and metal concentrations were consistent for the period. Flows ranged from 42 to 55 gallons per minute with an average of 49.9 gpm. Acid loadings were consistent as well ranging from 322 to 425 lbs/day and averaging 366 lbs./day. The consistency of the concentrations can also be verified by noting the Conductivity and Sulfate levels.

Table 2 displays data from the Fairfax Groundwater Monitoring well. This well was established to check for contaminants leaching from the Phase II demonstration area. No water has been collected from the mine so the likelihood of leaching is very low. However, the well is a security measure and will continue to be monitored. Similar wells will be established at the Phase III Longridge Mine site. Upon review of the data, it can be concluded that no contaminants are leaching into the well. The water is alkaline and metal concentrations are below action limits.

All analyses were conducted by the National Research Center for Coal and Energy's Analytical Laboratory. The NRCCE Lab is certified by the State of West Virginia for all analytes reported.

5.0 Plans for next Quarter

- 5.1 Continue monitoring the Longridge mine for water quality and flow.
- 5.2 Continue to monitor Fairfax borehole for possible contamination from grout.

Table 1 Longridge Mine Water Quality Data

Phase III Quarter I - December 1996 to February 1997

Date	01/04/97	01/11/97	01/21/97	02/12/97
Sample #	104	105	106	108
Flow (gpm)	50	52.7	45	55
Temp (C)	8	8	8	8
Precip (in)	na	0.56	0.19	na
pH	2.9	2.89	2.67	2.65
Con. (umo/cm)	1960	2050	2300	2000
Acid. (mg/L)	537	585	646	644
Acid. (lbs/d)	322.2	369.954	348.84	425.04
Fe (mg/L)	80	90	110	110
Mn (mg/L)	14	14	17	18
Al (mg/L)	42	47	46	41
Ca (mg/L)	83	93	110	120
Mg (mg/L)	48	52	59	78
SO4 (mg/L)	1000	1100	1100	1100
As (mg/L)	0.39	0.5	0.57	0.5
Se (mg/L)	0.42	0.44	0.5	0.46
Pb (mg/L)	0.11	0.11	0.2	0.15
Ba (mg/L)	0.011	0.012	0.003	<mdl
Cd (mg/L)	<mdl	<mdl	<mdl	<mdl
B (mg/L)	0.06	0.078	0.1	0.092

Table 2 Fairfax Groundwater Well Water Quality Data

Phase III Quarter I - December 1996 to February 1997

Date	01/11/97	02/12/97
Sample #	105F	108F
Flow (gpm)		
Temp (C)		
Precip (in)	0.56	na
pH	7.51	7.37
Con. (umo/cm)	540	430
Acid. (mg/L)	0	0
Acid. (lbs/d)	0	0
Alkalinity (mg/l)	140	123
Fe (mg/L)	0.33	0.42
Mn (mg/L)	0.086	0.084
Al (mg/L)	1.6	1.2
Ca (mg/L)	44	40
Mg (mg/L)	10	8.4
SO4 (mg/L)	120	96
As (mg/L)	<mdl	<mdl
Se (mg/L)	<mdl	<mdl
Pb (mg/L)	<mdl	<mdl
Ba (mg/L)	0.15	0.1
Cd (mg/L)	<mdl	<mdl
B (mg/L)	<mdl	<mdl

D. Contaminant Transport

1.0 Task Description

Task 6.0 Contaminant Transport

Determine how contaminants will migrate from the grout (if any) and determine how the water that was filling the void will interact with the impermeable plug filling the void after injection.

2.0 Summary of Quarters Accomplishments and Significant Events

2.1 The grout strength requirements were established to account for possible stress concentrations around mine cavities.

2.2 The Longridge Mine was idealized to perform contaminant transport studies and some example flow problems were solved.

3.0 To Date Accomplishments

3.1 The Longridge Mine was idealized for the task on modeling the contaminant transport.

3.2 A finite element difference grid for the idealized Longridge mine was constructed and some example groundwater flow problems were solved using the existing computer software.

4.0 Technical Progress Report

A technical progress report for this section will be presented in the next quarter as no conclusions can be drawn from current data.

5.0 Plans for Next Quarter

To continue the analysis of fluid flow and contaminant transport problems at the Longridge Mine.