ABSTRACT

The primary purpose of this project has been to identify and test concentrates made from preparation plant fines as to their amenability as feed for slurry fed, slagging, entrained flow gasifiers. The high sulfur value and high BTU value of Illinois coals are particularly advantageous in such a gasifier. Elemental sulfur is recovered as a revenue producing product in gasifier technologies, and the higher BTU Illinois coal concentrate requires less water to produce a pumpable slurry than western coal (30-35% vs 45%) thereby reducing the amount of heat lost in the vaporization of entrained water. This means that 66 tons of Illinois coal concentrate containing 13,000 BTU per pound, at 70% solids would provide as much net heat as 100 tons of 9500 BTU coal pumped at 55% solids.

Samples were obtained from the waste streams from plants treating No. 5 underground coal, No. 6 underground coal, multi-seamed surface mined coal, and from the waste pond from a plant treating No. 6 coal which had been in place for more than five years.

Most of the tests were conducted on waste streams which were minus 65 mesh, several were somewhat finer. All made acceptable grade concentrates usable for gasification. All were over 11,400 BTU per pound, and most were above 12,400 BTU per pound. Several of the analyses were submitted to Destec for Estimated Performance Analyses. These were reported at 8356 BTU/KWH for the concentrates made from No. 6 coal waste, and 8846 BTU/KWH for the concentrates from No. 5 coal. A heat rate for conventional steam power generation is 10,300 BTU/KWH. Williams Technologies, Inc. conducted viscosity tests on the same two samples and found them to be pumpable without the use of chemical additives.
EXECUTIVE SUMMARY

The coal industry of Illinois discards a significant amount of coal as fines from washing plants. A small amount is recovered in three flotation plants and several fine sized gravity separation plants which treat washing plant waste. An estimate is that about 4,000,000 tons of recoverable coal is being impounded as waste per year from the thirty existing washing plants. This coal, when concentrated by gravity and/or flotation approaches the size and chemical requirements for gasification.

The gasification of coal slurry is a technology which has been proven to be scientifically and environmentally effective. Integrated gasification combined cycle (IGCC) plants have the capability to achieve heat rates as low as 8200 BTU/KWH (42% efficient). Additionally, IGCC plants are largely waste free. The products are medium BTU clean gas, well below present or future limits of either sulfur on nitrogen oxides, steam, inert granulated slag, and elemental sulfur. The slag and sulfur are marketable; the slag has been examined by a number of State Highway Departments, including Illinois' and found to be acceptable for highway base use. The sulfur is sold for about $67.00 per ton in the midwest, and up to $115.00 per ton in the Florida market area. Illinois coal meets all of the desirable characteristics needed for gasification: first it can be concentrated to a grade higher than 13,000 BTU per pound as compared to about 9500 BTU per pound for western coal; second, it can be densified to over 70% solids and remain pumpable as compared to about 55% for western coals; third, the sulfur is a marketable, revenue producing product in a gasifier rather than a penalty as when Illinois coal is utilized in conventional coal fired power generation; and fourth, it is partially ground to plant specifications when it is delivered to an IGCC plant.

With these opportunities and advantages Illinois coal has over western coal, it was suggested that these opportunities be developed toward commercial usage. During the course of this contract, samples were obtained from the waste streams from plants treating No. 5 underground coal, No. 6 underground coal, Multi-seamed surface mined coal, and from the waste pond from a plant treating No. 6 coal which had been in place for more than five years. None of the samples had been through flotation cells, so no flotation reagents had to be considered in subsequent work.

Tests have been made on each of these. The goal was to demonstrate that saleable concentrates could be made from each, not to fine tune each of the products. That exercise was beyond the goals of this project, but sufficient evidence has been gathered to insure that concentrates in the order of 13,000 BTU/pound can be uniformly expected. The recoveries of the BTU's indicate that we would expect high recoveries from
the fresher materials, in the 75% to 95% range, but probably would expect the recovery of a clean concentrate from the impounded tailings to be in the 60% to 70% range.

The flotation concentrates which have been made during this testing program have been submitted to Destec Energy, Inc. for their Estimated Performance Analyses.

They resulted in Heat Rates of 8356 BTU/KWH for concentrates made from the waste streams when No. 6 coal is treated and 8846 BTU/KWH when the No. 5 coal treated. The heat rate generally expected in conventional steam power generation is 10,300 BTU/KWH. The efficiencies are 40.87%, 38.61%, and 33.16% respectively for No.6 by gasifier, No. 5 by gasifier, and conventional steam generation, or that the gasifier efficiency is 123.3% of the conventional steam generation.

The same concentrates were submitted to Williams Technologies, Inc. for their analyses of the pumpability of the slurries. They reported that while there was some difference, both could be pumped economically without the use of chemical additives. At our request they supplied an analysis of what it would cost to pump a slurry 300 miles, or the distance from the coal area near Rend Lake to Chicago. Their experienced calculation was that it would cost 2.3 cents per ton mile, this includes capital expense and operational costs, and is based on shipping 5,000,000 tons per year.

Earlier work by several of the investigators associated with this project led to the acceptance of Illinois Basin coal as gasifier feed. In turn, the Public Service Company of Indiana and Destec are constructing a 262 megawatt gasifier retrofit at PSI’s Wabash River Plant near Terre Haute, Indiana. This is funded by DOE, PSI, and Destec for $591 million and is expected to produce power in mid to late 1995.

The results of this project clearly show that a high BTU product can be made from the fine coal wasted by heavy media cleaning, that these products are acceptable feedstock for slurry fed gasification, and that these slurries can be delivered from the coal mining areas to the power plant locations in an efficient, clean and inexpensive manner.
OBJECTIVES

The goals and objectives of this project were to have coal from Illinois washing plant waste streams used for gasifier feed for power generation. To do so, this project utilized waste products from real plant waste streams from a variety of sources to develop a series of examples of concentrates which have low ash content, high BTU content, and sulfur which would be saleable when the coal is used for power generation using IGCC technology.

The coal industry of Illinois discards a significant amount of coal as fines from washing plants. A small amount is recovered in three flotation plants and several fine sized gravity separation plants which treat washing plant waste. An estimate is that about 4,000,000 tons of recoverable coal is being impounded as waste per year in Illinois. At $25.00 per ton, this represents $100,000,000 in annual revenue for the coal industry. This coal when concentrated by gravity and/or flotation approaches the size and chemical requirements for slurry-fed, slagging, entrained-flow gasification. There are presently enough coal fines mined and discarded in Illinois annually to provide fuel for a 2400MW power plant. This is much larger than any existing power plant in the state.

Samples of coal concentrates generated from several different plant sources were made and given a gasification amenability review to determine their acceptability as gasifier feed. In addition to current plant wastes, at least one sample of impounded waste was examined under the same criteria.

Additionally, several of these concentrate samples were tested for their potential as pumpable coal slurry. Earlier work indicated that existing pipeline technology had every reason to be a transportation method of choice.

This work at this time has a very important impact on the Illinois Coal Industry. Because of the recently legislated Clean Air Act, many of the markets for Illinois high-BTU, high-sulfur coal are in jeopardy. Three alternatives are available to users of coal to meet the mandated sulfur to energy ratios. First, substitute low BTU western coal for Illinois coal; this can be done either by total substitution, or by blending to a desired endpoint. Second, install scrubbers in any of their many forms, or lastly, adapt power plants to take advantage of the high BTU, high-sulfur feedstock available with Illinois coal. Illinois coal has ideal properties for integrated gasification combined cycle plants which produce power at about 25% higher efficiency than conventionally fired power plants, and produce no appreciable solid, liquid, or gaseous pollutants.
INTRODUCTION AND BACKGROUND

The gasification of coal slurry is a technology which has been proven to be scientifically and environmentally effective. Integrated gasification combined cycle (IGCC) power plants have the capability to achieve heat rates as low as 8200 BTU/KWH (42% efficiency); this is compared to 10,300 BTU/KWH for conventional coal fired generation (33% efficiency). Additionally, the IGCC plants are virtually waste free: the products are medium BTU clean gas, steam, inert granulated slag, and elemental sulfur. The slag and the sulfur are marketable, the sulfur at up to $115 per ton, and the granulated slag has been appraised by several different state Departments of Transportation, including Illinois' and found to be acceptable road construction material. A pulverized coal plant generates steam, slag in some form and either SO$_2$ or NO$_x$ gasses or scrubber sludge, neither of which is desirable. Destec Energy, Inc of Plaquemine, LA and Texaco's Cool Water plants have used several coals to prove their technologies, and both have used Illinois coals on controlled runs.

During the 1991-1992 contract year (with ICCI) the Illinois State Geological Survey contracted to study Gasifier Feed, Tailor-made from Illinois Coal. During the first two quarters products were made from Illinois coals in which the heat rate was reduced to 8490 BTU/KWH on real samples generated at Kerr-McGee's Galatia plant, a marked improvement when compared to either washed Illinois coal or western coal. The products from plant testing were submitted to Williams Technologies Slurry Pumping Test Facility in Flagstaff, AZ and found to be amenable to long distance pumping at high densities without additives.

EXPERIMENTAL PROCEDURES

Material for the testing program in this reporting period was obtained from four mines in Illinois. The first three were slurries of plant effluents from operating plants which do not use any flotation process. The fines were collected in the field, returned to Champaign, screened on 65 mesh to remove the oversized material, then stored for use. The fourth sample was collected from an old tailings pond. The material had never been through a flotation circuit, thus had no flotation reagent associated with it. It is as near representative as the operators could suggest, and had been placed in the pond for longer than five years. This material was removed to Champaign, slurried and screened on the 65 mesh screen for oversize removal.
The procedure was to acquire representative samples of the slurries described above, transfer them to a mix tank, adjust the solids to a range of 6% to 8%, then set the flotation feed rate in appropriate gallons per minute to deliver 10 pounds of dry solids per hour, the nominal feed rate for the Deister Laboratory Continuous Flow Flotation Column. The reagent feed rates to match the feed rate were calculated and started, then the feed was turned into the column. Every effort has been made on all tests to assure that steady state conditions were reached before any sampling was started. For the purpose of this work steady state has been reached when at least six volume changes of slurry have been fed into the column without a feed, tailing, air rate, or reagent rate change. This is normally a little over an hour.

MATERIAL BALANCES ON TYPICAL TESTS

Following we show material balances on several typical tests which were completed during the contract period. These are 1) Washing Plant Waste, No. 5 Coal, 2) Washing Plant Waste, No 6 Coal, 3) Washing Plant Waste from Surface Mining, and 4) Tailings Pond Waste. The duration of each of these tests and similar tests was from six hours to ten hours to insure that steady state conditions had been achieved, and that both concentrate and tailings flows from the flotation machine were consistent. For the purpose of this test work, steady state operation was achieved when about ten volumes of slurry had been fed into the flotation machine without any disturbance, and that there were no disturbances noted during the cycle of sample collection. In some cases sample collection was of over an hour duration while samples were being collected in sufficient volume for the viscosity tests, and Estimated Performance Analyses.

DISCUSSION

There are several unique features which are pointed out in the material balance sheets above: First, the grade of concentrate which is made from waste products from diverse sources is substantially the same, all near 12,000 BTU per pound; second, the recovery of the BTU's varies substantially, from 96% from the surface mined material to 67% for the impounded waste. The test work demonstrated in these tests achieve the goals of the project. It clearly shows that high-BTU gasifier feed can be produced from any of the four samples treated. Further testing of these samples or others could produce higher BTU recoveries and/or higher grades.

The results of Destec's Estimated Performance Analyses shows that on two of the samples, No. 5 coal, and No. 6 coals the
heat rates were reported as 8846 BTU/KWH and 8356 BTU/KWH respectively. This analysis is based upon the use of a designated coal in a gasifier plant, taking into account the melting point of the slag, as well as determining the heat value from the coal and sulfur values. Although noted earlier, the heat rate for conventional steam power generation is 10,300 BTU/KWH, thus the results demonstrated here indicate that the heat efficiency associated with the products generated by this research is 23.3% higher than would be expected in steam generation. The Analyses provided by Destec are appended hereto.

Samples of two of the concentrates generated during the flotation testing were submitted to Williams Technologies, Inc. for pumpability analyses. In both cases the samples were reported as pumpable with the requirement of chemical additives. The finer coal concentrate, that generated from the No. 5 coal showed a higher viscosity at any given percent solids. This is because with less course material in the slurry it becomes more thixotropic. This was also discovered with the work by this research team two years ago when samples of flotation fines and samples of the coal concentrates from the gravity spirals were tested individually. Neither was considered successful as a candidate for pumpline transportation, but when they were mixed in the ratio in which they were produced, they responded very much like the Black Mesa Pipeline Company feed which has been successful for fine coal transportation for a number of years. We would expect that any plant which is making a flotation concentrate from the very fine material would also be expected to treat the intermediate (-28 mesh x +100 mesh) size material and have it available for the same markets which the fine coal flotation is described for herein.

Williams further supplied a document which describes the pumping cost of fine coal concentrate at 2.3 cents per ton-mile which includes capital and operating costs. They used a 300 mile pipeline, approximately the distance from Pinckneyville to Chicago, and 5,000,000 tons per year as their basis for calculation. Their analyses and descriptions of pipeline utilization are found in the Appendix.
### COAL TEST DATA SHEET

**COAL TYPE**  Washing Plant Waste, No. 5 Coal,-100 mesh material only

#### MATERIAL BALANCE

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>% WT</th>
<th>ANALYSES</th>
<th>DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ash</td>
<td>T/S</td>
</tr>
<tr>
<td>FEED</td>
<td>100.00</td>
<td>34.63</td>
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<tr>
<td>CONCT</td>
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<td>32.63</td>
<td>83.88</td>
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**CONDITIONS:**

Feed Rate: 10.0 #/hr  
Collector: Kerosene  
Collector Rate: 2.5 #/ton  
Frother: MIBC  
Frother Rate: 1.99 #/ton  
Other: Froth Column 20-24"
## COAL TEST DATA SHEET

<table>
<thead>
<tr>
<th>COAL TYPE</th>
<th>Washing Plant Waste, No. 6 Coal, -65 mesh material only</th>
</tr>
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### MATERIAL BALANCE

<table>
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<tr>
<th>PRODUCT</th>
<th>% WT</th>
<th>ANALYSES</th>
<th>DISTRIBUTION</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ash</td>
<td>T/S</td>
</tr>
<tr>
<td>FEED</td>
<td>100.00</td>
<td>47.62</td>
<td>2.85</td>
</tr>
<tr>
<td>CONCT</td>
<td>44.24</td>
<td>13.93</td>
<td>3.50</td>
</tr>
<tr>
<td>TAILING</td>
<td>55.76</td>
<td>74.51</td>
<td>2.34</td>
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**CONDITIONS:**

Feed Rate: 10 #/hr  
Collector: Kerosene  
Collector Rate: 2.00 #/ton  
Frother: MIBC  
Frother Rate: 1.99 #/ton  
Other: Froth Column: 20-24"  
Air: 24 SCFH
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<thead>
<tr>
<th>PRODUCT</th>
<th>% WT</th>
<th>ANALYSES</th>
<th>DISTRIBUTION</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ash</td>
<td>T/S</td>
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<tr>
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<td>52.60</td>
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<td>CONCT</td>
<td>53.28</td>
<td>19.71</td>
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<tr>
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<td>46.72</td>
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<td>2.56</td>
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CONDITIONS:

Feed Rate: 10 #/hr
Collector: Kerosene
Collector Rate: 1.5 #/ton
Frother: MIBC
Frother Rate: 1.5 #/ton
Other: pH 7.45
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<tr>
<th>COAL TYPE</th>
<th>PRODUCT</th>
<th>TAILINGS Pond Waste</th>
<th>MATERIAL BALANCE</th>
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<tr>
<td></td>
<td>% WT</td>
<td>ANALYSES</td>
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<td>O/S</td>
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<td></td>
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<td>T/S</td>
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**CONDITIONS:**
- Feed Rate: 10 #/hr
- Collector: Kerosene
- Collector Rate: 1.5 #/ton
- Frother: MIBC
- Frother Rate: 1.5 #/ton
- Other: pH 7.3
ESTIMATED PERFORMANCE FOR VARIOUS ILLINOIS COALS (1)

<table>
<thead>
<tr>
<th>LAB SAMPLE #</th>
<th>C-33869</th>
<th>C-33977</th>
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<tbody>
<tr>
<td>Date Rec'd by Lab</td>
<td>03/28/94</td>
<td>05/16/94</td>
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<tr>
<th>COAL</th>
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<tr>
<td>Dry</td>
<td>1,956</td>
<td>2,250</td>
<td></td>
</tr>
<tr>
<td>As Received</td>
<td>1,939</td>
<td>2,276</td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>48.7</td>
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<tr>
<td>Oxygen Req'd (95%)</td>
<td>1,887</td>
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<tr>
<td>Slag Product</td>
<td>149.3</td>
<td>316.1</td>
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SYNGAS PROPERTIES

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<tbody>
<tr>
<td>Dry Composition</td>
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<td></td>
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</tr>
<tr>
<td>H2</td>
<td>28.59</td>
<td>28.70</td>
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<td>CO</td>
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</tr>
<tr>
<td>CO2</td>
<td>9.54</td>
<td>14.00</td>
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</tr>
<tr>
<td>CH4</td>
<td>3.11</td>
<td>1.66</td>
<td></td>
</tr>
<tr>
<td>Ar + N2</td>
<td>3.39</td>
<td>3.76</td>
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</tr>
<tr>
<td>Molecular Weight</td>
<td>20.6</td>
<td>21.2</td>
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<tr>
<td>HHV Heating Value</td>
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<td></td>
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</tr>
<tr>
<td>Wet</td>
<td>201.7</td>
<td>186.4</td>
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</tr>
<tr>
<td>Dry</td>
<td>300.9</td>
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</tr>
<tr>
<td>Net Power</td>
<td>268.3</td>
<td>262.7</td>
<td></td>
</tr>
<tr>
<td>Net Heat Rate (HHV)</td>
<td>8,356</td>
<td>8,846</td>
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</tr>
</tbody>
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(1) – Based on Destec coal gasification plant supplying syngas to a combined cycle plant utilizing a GE–7FA gas turbine.

RAD – 06/24/94

Note: Sample C-33869 is from No. 5 Coal
Sample C-33977 is from No. 6 Coal
ILLINOIS COAL
SAMPLE #1 PHASE TWO
From No. 6 Coal

viscosity (cp)

% solids by weight

- - - Viscometer Data
Black Mesa Pipeline, Inc.

1509 E. Butler Avenue
Flagstaff, Arizona 86001
602/774-5076

J. A. Shelley
General Manager

July 5, 1994

Mr. H. P. Ehrlinger III
Illinois State Geological Survey
615 Peabody Drive
Champaign, IL  61820

Dear Hank:

Attached is a report on the pumpability of the last two coal slurry samples sent to us in May and June of this year. We are referring to these as Phase Two samples since we ran similar tests on other coal slurry samples for you in 1992.

As it turned out both samples are pumpable, but due to the extremely fine and narrow size consist of sample number two, it would have to be pumped in the 40 - 45 percent range while sample one can be pumped in the 50 - 55 percent solids range.

It should be pointed out that once a project is defined and annual throughputs determined, a comprehensive laboratory program would be required to optimize system design.

If you have any questions, please feel free to contact either myself or Hank Brolick.

Sincerely,

Paul Pertuit
System Engineer

Att.

cc: H. J. Brolick w/att
ILLINOIS COAL
PHASE TWO

PUMPABILITY TEST PROGRAM

Williams Technologies, Inc. was contacted by Hank Ehrlinger of the Illinois State Geological Survey (ISGS) in the spring of 1994 about a cursory analysis of two more coal slurry samples to determine their pumpability. In 1992 similar tests were run for ISGS on other coal samples or combination of samples.

Sample #1 and #2 of Phase Two were received at Black Mesa Pipeline's slurry laboratory on 5/27/94 and 6/21/94, respectively. Particle size and solid specific gravity were determined for each sample and the rheological properties of each sample at various concentrations were determined.

SCREEN ANALYSIS

Fine solids which have been wetted have a tendency to bond together upon drying. For this reason, wet screening was utilized for the sieve analysis performed on the samples.

All screening is by Tyler mesh sizes.

| SAMPLE #1 |
|------------|----------------|
| TYLER MESH | % RETAINED | CUMULATIVE % RETAINED |
| +14        | .20        | .20 |
| 14 X 20    | 1.20       | 1.40 |
| 20 X 28    | 3.75       | 4.95 |
| 28 X 48    | 22.46      | 27.41 |
| 48 X 100   | 19.78      | 47.19 |
| 100 X 325  | 23.72      | 70.91 |
| -325       | 29.09      | 100.00 |

Page 1
SAMPLE #2

<table>
<thead>
<tr>
<th>MESH</th>
<th>% RETAINED</th>
<th>% RETAINED</th>
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<tbody>
<tr>
<td>+14</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>14 X 20</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>20 X 28</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>28 X 48</td>
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<td>.08</td>
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<tr>
<td>48 X 100</td>
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<td>.58</td>
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<td>100 X 325</td>
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</tr>
<tr>
<td>-325</td>
<td>80.55</td>
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</table>

SPECIFIC GRAVITY

An accurate knowledge of solids specific gravity is necessary for analysis of test results, as well as calculations of slurry specific gravity and design quantities such as flow rate and liquid vehicle requirements, etc.

Specific gravity is defined as the ratio of the weight in air of a given volume of a material at reference temperature to the weight in air of an equal volume of distilled water at reference temperature (ASTM Designation E12). The procedure used to determine the composite specific gravity of the samples was the pycnometer method (ASTM D 854-58).

SAMPLE #1

The average composite specific gravity of duplicate samples was 1.405.

SAMPLE #2

The average composite specific gravity of duplicate samples was 1.474.
RHEOLOGY

One of the key elements in the design of slurry pipeline systems for transport of solids such as the coal considered in this test program is the evaluation and application of slurry rheology.

A Contraves Rheomat - 15 narrow gap rotational viscometer was used to determine the rheological properties of the slurries investigated in this program. The principle of this instrument is Couette flow between two cylinders, one of which is rotating.

SAMPLE #1

This sample appears to be pumpable in the 50 to 55 percent by weight range and has a viscosity of about 140 cp at 55% concentration and 68°F. (See attached viscosity curve).

SAMPLE #2

This sample appears to be pumpable in the 40 to 47 percent by weight range and has a viscosity of about 128 cp at 47% concentration and 68°F. (See attached viscosity curve).

CONCLUSIONS:

While both samples produced a pumpable slurry, the second sample was made up of extremely fine coal (see screen analysis above), resulting in fairly high viscosities at concentrations above 48%. It did exhibit very good stability at concentrations as low as 40% and would, therefore, permit line operation for long periods at fairly low velocities. However, the fine particle size does limit the maximum economical concentration of the slurry to about 47% because of the increase surface area and, if shutdown over an extended period, could cause some restart problems.

The first sample on the other hand can be pumped at concentrations of 50 to 55% economically and does exhibit sufficient stability to allow for reasonable turndown during pipeline operation. Also, because of its coarser and more graded size consist, it does not pack as hard as sample two and, therefore, should restart after prolonged shutdown.
It should be pointed out that the screen analysis on sample 2 may not be accurate since the sample contained quite a bit of lint which was deposited on the screens.

A much more comprehensive test program would be required before a pipeline could be designed to handle either of these slurries.
July 18, 1994

Mr. Henry P. Ehrlinger III
1916 Forest Street
Eldorado, IL 62930

Dear Hank:

Per our telephone conversation we have prepared a cost estimate to build and operate a coal slurry pipeline approximately 300 miles long with a capacity of five million tons per year.

The hypothetical pipeline would consist of an 18 inch outside diameter pipe with six pump stations. Each station would have three positive displacement, 1500 horsepower pumps. Two would be needed for transport of five million tons and one would be a standby unit. Slurry storage and water handling facilities would be installed at each pump station to allow the pipeline to be displaced with water prior to a shutdown.

We have not included the cost of a slurry preparation plant at the pipeline origin or a dewatering plant at the terminus, since these are dependant on the actual make-up of the coal fines and the requirements of the IGCC facilities. We would not expect these costs to be significant given the feedstock available and the gasifier requirements.

The estimated total capital cost, in 1994 dollars, to construct the pipeline and pump stations is $149,400,000. Assuming 75% of the project is financed at 10% interest and a 20% return on equity is desired, the operating expense, including amortization would be $0.023 per ton mile. As you can see transport of coal by slurry pipeline is very economical.

As you are aware, Williams Technologies owns an interest in and operates the Black Mesa coal slurry pipeline.

Black Mesa Pipeline currently delivers 640 tons per hour of coal to Southern California Edison Company’s Mohave Generating Station in Laughlin, Nevada, and has a documented availability factor of 99%. The pipeline has been in operation for 24 years and has shipped 85 million tons of coal over that period. The pipeline has delivered 28 million tons over the last five years under Williams Technologies, Inc. management.
The pipeline system facilities include a coal preparation plant and four pump stations. The purpose of the coal preparation plant is to (1) grind the coal to an engineered design particle size distribution; (2) mix the fine coal with water to make a slurry which is approximately 50% solids by weight and (3) retain the slurry in agitated storage tanks prior to injection into the pipeline.

In addition to the initiating pump station, located adjacent to the coal preparation plant, there are three intermediate pump stations along the pipeline to provide the energy required to move the slurry to its' destination. All pump stations are equipped with positive displacement pumps.

Operation of the entire pipeline system is monitored and controlled from a central control room in the operations building at the coal preparation plant. The intermediate pump stations are remotely controlled via microwave linkage to the central control room. The pipeline system operates on a 24-hour, 365 day per year basis. The system has sufficient standby equipment to permit scheduled preventative maintenance while the pipeline is operating. Major maintenance is generally performed during the time that the electric power generating station is in a planned shutdown mode.

There are numerous advantages to the transport of coal using coal slurry pipelines. Many of them can be quantified such as lower coal losses during transportation, lower capital and operating costs and high reliability. Others such as lower environmental pollution and less surface traffic interruption, although not easy to quantify, are nevertheless real advantages. Exhibit "T" lists some of the advantages of a coal slurry pipeline.

I hope that this data will be helpful to you in your presentation. Also attached, are two slides from Hank Brolick, which he would like returned.

Please call if you need additional information.

Sincerely,

[Signature]

Paul F. Perisho
Vice President

PFP:rc

cc: H.J. Brolick

Enclosure
Exhibit "I"
Advantages of a Slurry Pipeline to Railroad Transport

1. Not environmentally intrusive.
2. No interruption of highways and railroads.
3. Safer, no risk of traffic accidents and if a pipeline leak occurs, only water and non-hazardous coal are released.
4. The water recovered from the slurry replaces part of the power plant cooling water requirements.
5. Grinding required for slurry transport reduces the grinding required for coal cleaning and the grinding required at the power plant.
6. Less coal is lost. The average coal lost during rail transport as dust and spillage in the United States is 1% to 3%. Only .03% of the total coal is lost by Black Mesa Pipeline and this is lost in the water leaving the clarifier tank at Mohave.
7. Slurry pipelines are more reliable, 99% + availability.
8. Slurry pipelines are less expensive to build and operate.