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FEASIBILITY OF A CONTINUOUS SURFACE MINING MACHINE USING IMPACT BREAKERS

First Quarterly Report
Contractor—Foster-Miller Associates, Inc.

January 1980

Contract No. AC01-79ET-14270

U. S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Coal Mining

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FEASIBILITY OF A CONTINUOUS SURFACE
MINING MACHINE USING IMPACT BREAKERS

First Quarterly Report
for the period
1 October 1979 - 31 December 1979

Allan T. Fisk (Project Manager)
Roger J. Simpson (Project Engineer)

Foster-Miller Associates, Inc.
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U.S. Department of Energy
Assistant Secretary for Energy Technology
Division of Fossil Fuel Extraction
Mining Research and Development

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ABSTRACT

This is the first quarterly report on the efforts to evaluate the feasibility of excavating coal and overburden from surface mines using impact breakers. The initial stages of the project are devoted to a literature search, equipment selection, test site selection, and conceptual test system design. Hence, this report details the progress made in these areas; the next quarter will see the finalization of Phase I. Included as appendices to this report are FMA internal reports on the individual mines visited. These reports are the basis of the test site selection, and have been censored here to remove data the mine operators deemed as confidential.

TECHNICAL PROGRESS REPORT

Task No. 1 - Selection of Field Sites for Parametric Tests

Eight western surface mines were visited in Montana, Wyoming, Colorado (3), New Mexico (2), and Indiana. The geological conditions represented the extremes of the range of conditions expected in western surface mines for both coal and overburden. As the appendices indicate, interest in the impact breaker concept varied from enthusiastic through indifferent to total rejection. Willingness to cooperate with this research was directly proportional to interest. A general consensus to the application of this concept to a mining machine was, that with present mine plans, using impact breakers to remove deep overburden was impractical and the possibility of a change to terraced mine plans with conveyor systems was futuristic. However, those mines with multiple, perhaps thinner seams, all expressed interest in the excavation of coal and parting to eliminate shallow blasting. These two points indicate that a mining machine might better be configured in the "scraper" mode rather than the "plow" mode, and must have the ability to sump in at blind pit ends.

Mine operators were split on the question of tires versus tracks, as they were on whether the machine should be single purpose or an attachment to a universal power module.

It was quite apparent using our visits that the more northern mines experienced extreme climatic conditions in the winter which would probably hinder the tests, if not the testers.

Presently, letters of intent from the mine operators are being solicited. Their receipt is prerequisite to selecting two mines for parametric tests.

Task No. 2 - Selection of Impact Hammers for Field Testing

Two hammers have been selected to represent the fluid tappet type and the conventional steel tappet type in the initial single hammer comparison tests. They are the Joy Hefti 411A and the Contech HD-10, respectively. The Joy was the only fluid tappet hammer in the required blow energy range, and the Contech was chosen after considering blow energy, price, weight, simplicity of field service, and easy adjustment of blow energy. However, a second choice of conventional hammer, not previously considered, is being evaluated at this time, based on the above factors.

Task No. 3 - Design Test System

The tracked carrier for the Self-Advancing Miner (SAM) Project will be used as a basis for the Impactor Test System. Detailed design of the modifications to the SAM vehicle is in the final stages, and instrumentation selection is in process. The basic modifications are as follows:

- a. Mounting of the two hammer types with the degrees of freedom necessary to allow for the required configuration variables
- b. Removal of the SAM mounting
- c. Increased width and length of wheelbase for greater stability under increased dead load and live forces
- d. Increased wheel size and lower ground clearance for greater load bearing and structural integrity
- e. Increased stiffening of upper structure to accommodate higher stress levels.

Balance of Phase I

The conclusion of Phase I coincides with the end of the second quarter. Hence, the second quarterly report will be in the form of the Phase I Final Report.

M E M O R A N D U M

TO: A. Fisk

FROM: A. Mangolds
R. Simpson

SUBJECT: Mine visit to Colowyo Coal Co., Colorado

DATE: 17 January 1980

Colowyo Mine

Colowyo Coal Company

PO Box 775

Craig, CO 81625

303-824-3474

(Roughly 24 mi S. of Craig, right side of Rt. 13)

Contacts: Ted Showalter
Tom Behling, Mine Engineer

Summary

Mr. Showalter reviewed our project and Tom Behling provided us with an excellent tour. Other engineers, including the President/General Manager Ira McKeever who were originally scheduled to meet with us were otherwise occupied. A snow storm was brewing so that the review was kept short. More detailed information can be obtained via Mr. Showalter.

The Colowyo mine extracts 10 seams from a soon-to-be single pit. Seams and topography parallel one another with a grade of 10 percent. Mining proceeds up dip with an overall highwall slope of 70 percent (crest to toe). The pit is terraced, however not uniformly as in an open pit operation. Several truck-shovel

operations take the stratigraphically higher overburden and coal, while a dragline deals with the lower seams. The pit length is 4000 ft.

Colowyo is still under development so a good fix on pass times could not be established. Guessing from the number of terraces available, we should be able to fit in some where. Bench heights are 20 to 150 ft high, though lower heights could probably be found. Numerous outcrops abound. The geology is complex (relative to the Wyoming and Montana sites). Fracturing or jointing is relatively frequent (locally 2 to 5 ft spacing) and the strata is often thin. Picking a suitable site which combines all of the tests needs may (again may not) be difficult. Climactic conditions in the winter would probably be quite discomforting for equipment and personnel.

Permission for testing will have to be through McKeever.

[REDACTED]

[REDACTED]

[REDACTED]

Comments on the I/B

Ted Showalter was the only one to review the impact breaker. His comments follow.

- Track is preferable to tired undercarriages.
- The undercarriage would have to be well designed. They are experiencing problems with their shovels, due to a side hill operation (?).
- The removal of partings would appear to be the best application.

- Principle competition in terms of cost efficiency would be front end loaders and hydraulic excavators.
- The system should be capable of cutting below grade, then along the side hill for bench work.
- The system should be capable of cutting into corners.
- MSHA won't allow working a highwall with a unit that is lower than slope height. The I-R concept would have to cut the slope way back or be a gargantuan machine.
- Scheduling haulage equipment to keep up with the I/B unit, whose bench haulage distance is rapidly changing would be difficult. Shovel systems are much more static and therefore simpler to interface.
- Should look at space requirements, turn radius, etc. if looking at benching (including trucks).

Geology

Unfortunately we had little opportunity to inspect or discuss the geology of the pit. 10 seams are being mined simultaneously from a single pit. The pit is presently split into two pits, separated by a haulroad. The two pits were developed separately and there is some concern that the haulroad may be aligned on a fault. If existing, the offsets across the two pits would only be 20 ft maximum. Interburdens are tough sandstones and moderate to soft shales. The haulroads are faced with locally quarried reddog which turns muddy when wet. Strata thickness can vary from 1 to 2 ft to massive, with sharp lithologic contacts. Jointing is well developed, subparallel to the strike of the pit. Joint

spacing varies across the lithologies and can become as frequent as 1 ft. Local slips in the highwell and haulroads were evident. SEveral perched ground water tables drain into the spoil. Coal undulations or rolls occur occasionally reaching 10 percent grades (along the strike).

Pit Layout

Colwyo is still considered to be under development. Full production should be realized in early 1980. The pit length is 4000 ft and mining occurs up dip. Topsoil is removed with front end loaders and 50 ton trucks. Self leveling scrappers have not worked due to boulders in the topsoil. The upper benches are removed by truck-shovel operations. Rock haulage is presently done with 120 ton end dump Unit Rigs, while 20 more 170 ton rock trucks are on order. The haulage circuit is 10,000 ft one way. The stripping shovels are one M-191 and two PH-2300 13-1/2 yd³ front end loaders load coal and suppliment the shovels as does a PH-1200 hydraulic excavator. [REDACTED]

[REDACTED]. Two BE draglines (1300-W, and 500 W with 37 and 25 yd³ buckets respectively) work the deeper section of the pit using the haulback method.

Blasting is accomplished with two 45 R BE drills, making 9-7/8 in. hole. Powder factors vary from .63 to .69 lb/yd³, broken (15 percent swell factor). [REDACTED]
A home made Simpco dual boom drill mounted on a BE cranebody drills coal. They have experienced overheating of the hydraulic system and air starvation to the drill tool. The unit can use either rotary or anger drills and the spacing between booms are variable. They like the system alot, however availability is only 50 to 60 percent.

MEMORANDUM

TO: A. Fisk
FROM: A. Mangolds, R. Simpson
SUBJECT: Mine Visit to York Canyon, New Mexico
DATE: 16 January 1980

York Canyon Mine
Kaiser Steel Corporation
P.O. Box 1107
Raton, New Mexico 87740
(505) 445-5531

Contacts: Mr. M. Durrance, General Superintendent, Strip Mine

Summary

Mr. Durrance reviewed our project and toured the pit with us. He was extremely cooperative and invited us to consider York Canyon for a test site. Unfortunately, he is considering retiring at the end of 1980 and he noted that he could not guarantee the cooperation of his heir. We were scheduled to talk with the chief engineer, however he was sick that day. The property is split up by canyons and ridges so that a fair amount of jockeying of equipment takes place. Several areas of coal are uncovered for stockpiling purposes. A test site could take advantage of one of these stockpiling sites. The chief disadvantage of the York Canyon mine would be the relatively high fracture frequency and thinner strata. The coal is split up by partings which would mean a maximum coal test section thickness of 6 feet.

Comments on the J/B.

The Easi-Miner is operating in York Canyon to load coal. Mr. Durrance's comments are therefore backed with some experience in continuous surface miners.

- The bottom-cut principle did not allow for natural blending of the coal. There is often a distinct vertical zonation of coal properties

- A truck must wet down the coal to suppress dust. It would be nice if an integral dust suppression system could be incorporated into the miner
- The Easi-Miner did not produce too many fines
- A 50 foot chute to get a 17 foot clearance is needed; could cause tipping problems in some cases
- Should produce 1000 to 1200 ton/hour; coincident with their breaker unit
- Spillage is not a problem with the spotting of trucks. The Easi-Miner stops forward movement while the trucks are changing out, though the cutting drum still turns
- The Easi-Miner cuts faster than it needs to, though capable of 36 inches the cut depth is 18 to 20 inches
- The speed of advance is critical to the efficiency of the belt load, truck follow-up and power consumed
- A spotter is required to see what the miner is cutting. A better system should be developed where the operators can determine what is happening
- Due to seam rolls, cutting height should be variable
- Durrance feels that the overburden would be too tough for the I/B system. Feels machine would have to be too heavy
- Grizzly size will not accept greater than 30 inches
- A tire type undercarriage is better than track due to the increased flexibility. Unit Rig had some tractive force problems
- The screw conveyor is viewed as a high dust, high maintenance item
- There may be a problem loading the cut rock onto the belt
- Does not see any advantage to making a flexible machine. If the unit works, it will be used all of the time. Cost and reliability will be the ultimate deciding factor. Efficiency, less so.

Geology

The York Canyon mine extracts the York Canyon Seam of the Raton formation (U. Cretaceous) and is 6 to 13 feet thick. The seam is characterized as a metallurgical coking coal and is analyzed at 8 percent moisture, 7.5 percent ash, 0.5 percent sulfur and 14,340 BTU. The York seam is essentially flat lying, however, the hilly topography severely interferes in pit layouts.

Present overburden depths are 70 feet, or a strip ratio of 6:1. The pit is presently approaching a hillside where the ratios projected reach 15:1. A number of draws and burn areas presently divide the pit into smaller 1/4 mile long pits. On the next pass the pits will join for a pit length of 1 mile. Overburden is a series of carbonaceous shales, siltstones and sandstones. Exposed sections indicated strata thicknesses of 4 to 20 feet. Jointing appears to be frequent, however, they may be a result of blasting. The York seam is split by a 10 inch and 2 foot shale parting. The coal splits and coalesces along the pit strike. The sandstones appear moderate to hard, while the shales appear soft to moderate. The seam contains several 5 to 10 percent rolls.

Pit Layout

The York seam is presently dissected by draws and burn areas. On the next pass the pits should link up to form a single, 1 mile pit. As the pit approaches a hillside, a truck-shovel operation cuts down the hillside to a more manageable height for the dragline. A 41 yd³ 752 dragline (285 foot boom) operating off the highwall works the 150 foot wide pit. As the overburden gets deeper the pit width will decrease to 110 feet. The overburden is shot with a Marion drill. A new drill will angle the holes 10 to 12 degrees from the vertical. The powder factor for the overburden is 3/4 lb/yd³, at 80 percent ANFO. Coal is ripped by a D9 No. 41 single tooth, across the pit. Double teeth are too weak. Coal is loaded out with the Easi-Miner and a 12-1/2 and 15 yd³ front end loader. It looked like a narrow fender was left to stabilize the spoil. Coal was hauled by 150 ton Tenex bottom dumps.

MEMORANDUM

TO: R. Simpson
FROM: A. Mangolds, A. Fisk
SUBJECT: Mine Visit to Chinook Mine, Indiana
DATE: 16 January 1980

Chinook Mine
AMAX Coal Company
P.O. Box 8
Staunton, Indiana 47881
(812) 894-2385
(Approximately 20 miles east of Terre Haute, off I-70)

Contacts: Levi Rigney, Manager Mid-West Operations
Dale Teeters, Mine Manager

Summary

Our interview and mine tour involved the above two gentlemen who brought forth a substantial amount of experience. Both were very cooperative, especially considering the value of theirs' time.

[REDACTED]

The Chinook mine operates two pits with an average strip ratio of 26:1. Pit widths varied from 70 to 150 feet and lengths were about 1 mile. A glacial outwash channel intersected the southern pit, effectively dividing it into three subpits. Six seams are mined between the two pits. This all makes for tight scheduling and congested areas.

The six seams mined were 1, 1.2, 1, 1.1, 3.1, and 2.0 feet thick. The overburden was in places very hard although the strata associated with the coal was relatively thin, and tended to pinch and coalesce. Finding a thick, consistent test section would be extremely difficult, however, it would be an excellent 'tough' test case. In addition, the pits were subject to water inundations along low spots in the pit.

Comments on the I/B Concept

The following comments were forwarded by Mr. Rigney and Mr. Teeters:

- Felt there may be some thrust problems in the harder overburden
- They liked the ability to cut below grade because wider cuts may be used and it is easier to transport rock
- It should work well in truck-shovel operations. Suggested we look at some around Gillette
- May be of some use where coal freezing is a problem to replace the 'headache' ball
- Suggested that a tough test case could be found in some of the West Kentucky surface mines, where a 7 foot limestone parting is ripped with a core ripper [REDACTED]
- A backhoe and hammer were tried on partings, but was too slow
- They feel that the carriage would have to be extremely heavy to withstand the shock and vibration. This may cause a mobility and flotation problem on wet clay floors
- Shooting the parting is a very high cost and safety problem. Congestion due to the many operations required was also a problem. The I/B concept would be of great help in parting removal
- A I/B with the ability to cut below grade would be much more adaptable to present mining schemes
- How the initial cuts would be made with the side cut scheme was questioned (box cuts)
- They liked the two-way cutting technique but were curious as to its utility in the corners
- The parting thicknesses vary considerably and the interfaces roll. Adjustable cut lengths will be required
- Vertical joints intersecting the strike of the pit at a low angle may pull the cutters into the highwall
- They felt that the scheme fit in best with the Leahy mine where a 45 foot parting is taken with a dragline

- The I/B would have to compete against the shovel which is a relatively low cost item and has an 85 to 95 percent availability. Shovels are heavy, not stressed and do not have any small moving pieces
- The pit should be started and finished without a driller
- If have thick, tough parting, the I/B will need 'a hell of a horse'
- The I/B should cut out front instead of in the center like the east miner
- Should be able to produce approximately 2000 ton/hour or 1000 yd³/hour
- They go after an 18 inch seam with a 3 inch to 2 foot parting overlying it. The cutting mechanism should therefore be good to a 3 inch cutting accuracy
- An electric system would be nice due to high Diesel costs

Geology

The Chinook mine accesses the No. 3 seam (Seelyville fm., lower Pennsylvania), and five other minor seams for an accumulated thickness of 86 inches. The No. 3 seam is analyzed as 11.3 percent moisture, 11.2 percent ash, 3.05 percent sulfur and 11,080 BTU. Partings between seams range from 3 inches to 45 feet. Partings may be shales to limey shale and often must be blased. Overburden is principally friable sandstones, shales and a very tough limey shale. Jointing is infrequent, intersecting the pit at low, vertical angles. Seam, parting and overburden strata lense frequently, and 10 foot rolls in 200 feet are not uncommon. Six seams are mined with 1, 1.2, 1, 1.1, 3.1, 2.0 foot thicknesses. The variability in geology requires a final exploration grid of 120 feet. A glacial outwash channel intersects the southern pit at the mid-point and is about 1200 feet across and 50 to 80 feet deep. The channel is a natural aquifer which, with its unconsolidated nature, causes highwall instabilities. Water must be pumped from the pit floors. Top soil is 4 to 10 feet thick.

Pit Layout

The Chinook mine is divided into two pits (north and south). Pit lengths are approximately 1 mile long and 80 to 110 feet deep. Strip ratios are 30 and 25 or an average of 26:1 (!?). Mining occurs 364 days a year, three shifts per day in overburden, and two shifts per day in coal. Pit widths vary from 70 feet in the southern pit to 150 feet in the northern pit. Drag lines with 85 yd³ buckets

sidecast the majority of overburden and thicker (710 feet) partings. An 11 yd³ Marion 151 and 12 yd³ Marion 182 shovel works in the pit loading coal and placing the interburden in 60 foot high spoils. A 15 to 20 foot fender is often left to stabilize the spoil stacked by the shovels. Haul roads are on the parting or coal while the shovel works on the pit floor (see Figure 1). Spoil slopes are 1-1/4:1. Spoil swells 25 percent.

Overburden is drilled with BE 60R drills, 15 inch holes. Powder factors are generally 0.5 lb/yd³ for overburden and 0.17 lb/yd³ for the parting. [REDACTED]

Parting is shot through 6-1/2 inch holes and is considered a high cost operation. Coal is ripped with a single tooth D-9.

Haulage ramps out of the southern pit go through the spoil while the northern pit cuts its ramps into the highwall. They have 19 scrapers to remove top soil and for reclamation. Top soil becomes extremely soft in the wet seasons such that lightweight D-6s have flotation problems.

The southern pit with its outwash channel problems is to be modified in the next few cuts. A mine plan shown in Figure 2 will help stabilize the highwall although some coal will be left behind. A stump containing the glacial outwash will be left on the initial pass. Operating off of the surrounding solid rock, a box cut behind the stump will be side cast into the pit. The solid overburden in sections 2 and 3 will then be removed to straighten out the pit. Sections 5 and 6 will then be taken leaving a stump again and the process will continue. It is calculated that the lost coal will be a cheaper alternative than the rehandling presently necessary to stabilize the outwash.

(PREPARED BY)	(DATE)	(REPORT NO.)
(CHECKED BY)	(DATE)	(PROJECT)
TITLE

M E M O R A N D U M

TO: A. Fisk
FROM: A. Mangolds
R. Simpson
SUBJECT: Mine visit to the Navajo Mine, NM
DATE: 16 January 1980

Navajo Mine
Utah International, Inc.
PO Box 155
Fruitland, NM 87416
505-598-5861

Contacts: Mr. Wes Karna, Mine Engineer

Summary

Vehicle problems with our rental forced us to be late for our interview. Unfortunately Mr. Karna had a tight schedule which resulted in a short session (the meeting following ours involved a whole gang from Unit Rig). Our interview consisted of Mr. Karna and several other staff engineers. Our mine tour unfortunately was led by an engineer who apparently hadn't been to the pits in a long time. The engineers were very cooperative and Mr. Karna agreed that we should request a letter of confirmation for the test program.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] Navajo has four pits each with different seams, and overburdens. The overburden is uniform and soft. Partings up to 10 ft thick exist in some pits.

Coal is not exposed in outcrops however pit lengths are 2 mi allowing for ample test times. The engineers noted that the caprock on the mesas were difficult to comminute and would provide a good overburden test. Climactic conditions are moderate year around.

Comments on I/B

Comments or questions on the impact breaker system follow:

- The Engineers were curious as to how a pit would be started. The I/B must be side cutting on both sides and capable of cutting below grade, for box cuts. Cut rock must be transported out of a box cut in some fashion.
- Anaconda experimented with a machine using hydraulic impactors. The hoses all broke because of the shock transfer.
- The screw conveyor would be a high maintenance item and cause too much dust. [REDACTED]
[REDACTED]
- They feel the I/B would fit in well with a truck-shovel operation.
- They liked the Melrose power train, especially the mobility.
- The I/B should work well where multiple seam mining is occurring. They presently use a dragline if the parting is greater than 10 ft.
- They like cutting below grade better than the side wall plow concept.

- There is no water in the pit, and dust is a severe problem. Should incorporate a dust suppression system.
- They don't feel that their drill-blast cycle is very expensive. (Powder factors are very low (.2 to .4 lb/yd³)).

Geology

The Navajo mine principally extracts the No. 6, 7 and 8 seams of the Fruitland formation in the Navajo field. Eight seams are mined in total. Four pits operate on the property, each accessing a different seam with unique properties. Overall blend results in 13.2 percent moisture, .72 percent sulfur, and 9,200 BTU. Though the seams are relatively flat lying, 4 foot rolls every 100 ft or so are common. The overburden is generally soft although lenses of hard sandstone occur within the overburden and as caprock for the mesas. Spontaneous combustion of the coal is common and occurs even within the highwall.

Pit Layout

Four pits operate at the Navajo mine. Three BE 1350-W, 50 yd³, 285 ft boom draglines open up pits with 100 ft wide floors, using the extended bench method. Overburden is shot with a .38 lb/yd³ powder factor while coal has a factor of .2 lb/yd³. Pit lengths average 2 mi. Front end loaders load the coal into WABCO 120 ton bottom dumps.

M E M O R A N D U M

TO: A. Fisk
FROM: A. Mangolds
R. Simpson
SUBJECT: Mine visit to Jim Bridger Mine
DATE: 14 January 1980

Jim Bridger Mine
Jim Bridger Coal Co.
Rock Springs, WY 82901
307-382-9741

I-80 E, from Rock Springs. Point of Rocks exit, under I-80, right, approximately 4 mi to powerplant. Mine office on NE side of plant.

Contacts: Mark L. Bricker, Assistant Mine Engineer
Glan Goss, Mine Manager
Steve Biel, Chief Engineer
Gary Yoakum, Mine Engineer

Summary

The impact of our meeting at Jim Bridger was blunted by the absence of the Chief Engineers. Our talks involved only assistant mining engineers, who, though helpfull would not comment on the impact breaker concept. Information gathered was therefore limited to their own operation. If we decide to try Jim Bridger we must make a personal presentation to Steve Biel, Cheif Engineer. The likelihood of cooperation is unknown.

The Jim Bridger mine is a large captive operation feeding the three unit Jim Bridger power plant at a rate of 5.5 million tons per year. There are presently two pits, 6 mi in length (total). They are eventually (next year) going to connect the pits together and possibly extend south to have an overall pit length of 9 miles. Only one seam (the Deadman) is mined, however a sandy shale parting requires a separate blast-haulage cycle. The pit is plagued by occasional water inundations. The highwall consists of sandstones, siltstones and shales ranging from soft to moderately hard. Overburden is presently 80 ft deep, although the expected pit limits will encounter 250 ft depths. It would appear that if a block of coal is left for testing, the area would not be interfered with for some time. Geologically, the site would be relatively easy to moderate. Finding an area to test the overburden may be difficult.

[REDACTED]

[REDACTED]

Comments on the I/B

The only comments that we could solicit on the advantages and disadvantages of the I/B concept were that if it worked, cutting off of the floor, it would help a lot with parting removal, and possibly on haulroad maintenance. He liked the tire concept but questioned the increased maintenance, operator and fuel cost required to transport cut overburden. Could see a use in truck-shovel operations. Would like to see a dust suppression system incorporated.

Geology

The Jim Bridger mine is extracting the Deadman seam, which is 25 to 30 ft thick. Typical analysis indicates 20.5 percent moisture, 9.7 percent ash, .47 percent sulfur, and 9,350 BTU per pound. The seam splits in local areas into a 2 to 3 ft lower seam. The parting is a sandy siltstone which locally gets up to

40 ft thick. The parting becomes slippery when wet. The Deadman seam dips 2 to 5 degrees to the east so that the present overburden of 80 ft will increase to 250 ft at the pit limits. A large burn area presently splits the seam into 2 separate pits. The topography is flat. The overburden is a series of siltstones, clayey shales, carbonaceous shales, and sandstones varying from soft to moderately hard. Coal is flaggy to slabby, cleat is poorly developed. Occasional boulders in the topsoil of up to 10 ft in diameter complicate scrapper haulage. The overburden is relatively competent with vertical jointing occurring at roughly 5 to 10 ft intervals. Perched water tables have caused local flooding as much as 6 ft deep. Water is pumped back into the spoil area. Further details of the site geology or hydrology can be obtained from Bill Gerhart at the corporate office in Portland, OR.

Pit Layout

Coal production at the pit 20,000 tons per day on a two shift basis. A Marion 8200, Page 757, and a Page 732 dragline are being used with 72, 60 and 20 yd³ buckets and 315, 326, and 225 ft booms respectively. Pit widths vary from 110 to 180 ft and the extended bench method was used at the pit we visited. Eventually a haul-back method will be used. A 5 ft coal berm and fender was left to stabilize the spoil toe. Overall recovery was 95 to 98 percent. The fender was reclaimed with a hydraulic excavator when ever possible. Haulroads are through the spoil. Ramps are 7 percent while roads are at a maximum of 3 percent grade. Belts are being considered for coal transportation to the blending facilities at the plant. Cut coal gets up to 4 ft slabs. 60R BE drills, 12-3/4 in. diameter holes are used for burden blasting with a .4 to .5 pound/yd³ powder factor. An I-R rig shoots coal, parting and coal with powder factors as high as .7 lb/yd³. The parting is shot seperately.

Coal is loaded with two 18 yd³ BE shovels or a 15 yd³ front end loader. The front end loader generally handles the parting unless it is too thick, where upon the dragline takes over. On occasion the parting is ripped and a scrapper hauls out the parting. Haulage is with 12 120 ton WABCO 85C's and four 85 ton Wabco end dumps. Tractored vehicles are kept off of the coal, while the other vehicles are kept off of the poor floor. Reclamation is accomplished with D-95 and Wabco and Terex 24 to 28 yd³ scrappers.

M E M O R A N D U M

TO: A. Fisk
FROM: A. Mangolds
R. Simpson
SUBJECT: Mine visit to Energy Fuels Mine
DATE: 11 January 1980

Energy Fuels

PO Box 6

Steamboat Springs, CO 80477

303-879-3800

(roughly 20 mi. s.w. of Steamboat, can be reached via Hayden also)

Contacts: Gib Lazor, Production Superintendent

Summary

[REDACTED]
[REDACTED] . Mr.
Lazor's only comment on the impact breaker concept (I/B) was that he could not see how it could do better than what he had. Considering his mining situation that's probably true. Two seams are mined, the Wedge (96 in. thick) and the Fish Creek (4 ft thick) in three to five pits. Both seams dip 10 to 16 degrees to the north with the overburden varying from 20 to 120 ft, or an overall strip ratio or 8.5:1.

The geology is simple with no partings, significant cleat or problem strata. Robbins and I-R drills sink 9-7/8 in. or 7-7/8 in. diameter blast holes depending on cover depth. Powder

factors are .55 to .6 pound/yd³ in the overburden, and .24 lb/yd³ in coal. Drill patterns vary between 16 x 16 ft to 21 x 21 ft.

Three draglines are presently used 14, 21 and 55 yd³ buckets. The 55 yd³ is a Mariin 8050, 325 ft boom. A 8 yd³ dragline removes overburden to 30 ft depth, the 14 and 21 yd³ draglines work overburden down to 60 ft, while the 55 yd³ dragline cleans to 120 ft. Pits work up dip, and permit restrictions have constrained pit limits to 2000 ft. Pit floors are 100 ft wide. L-80 loaders with 20 yd³ buckets load 50 ton bottom dump Euclids, and Good berry 100, 175's. Obtaining sufficient loading height is sometimes a problem due to the high grade in the pit. A shovel is used for box cuts. Where overburden is less than 30 ft a scrapper-loader/dozer team handles overburden removal.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] EFC is probably a dim candidate for testing.

M E M O R A N D U M

TO: A. Fisk
FROM: A. Mangolds
R. Simpson
SUBJECT: Mine visit to the Trapper Mine
DATE: 11 January 1980

Trapper Mine

Utah International
PO Box 187
Craig, CO 81625
303-824-4401
(approximately 6-1/2 mi S. of Craig off Rt. 13)

Contacts: John Pollard; Manager Surface Operations
R. Diederich, Mine Manager
R. Leitzman, Assistant Mine Manager
T. MacLean, General Mine Foreman
Several Others

Summary

Our principal contact was John Pollard. We met with the entire engineering staff, who reviewed our project and made the comments noted below. The operation has 3 pits (Enfield, Derringer, Ashmore), multiple seams, and is steeply pitching (16 percent). Climactic conditions limit the number of months topsoil can be handled (3 to 5 out of the year). Pit lengths are limited to one mile maximum (Derringer pit) reducing to 1800

ft in the Ashmore pit. Extreme care is required of scheduling procedures, with several operations going on in a pit at a given time. Friendly cooperation with the engineers would be anticipated for any testing program.

The mine is a captive operation supplying the plant with 2.7 million tons per year (MTPY). Outcrops abound so that overburden testing would be simple, however the coal tests would require severe constraints in scheduling. This infers that Trapper would be a poor to moderate choice. The mine engineers suggested we test the system at their Cedar City, Utah iron ore mine (York Jones is Mine Manager).

Geologically the Trapper mine offers a variety of conditions. The seams dip 14 to 20 percent. Four seams are mined (only two per pit), however several thin 2 to 4 in. riders exist which are mixed in with the parting and lost. They have an interburden or parting problem requiring supplemental blasting. Cleat and joint orientation is significant enough that they try to align the blastholes parallel to the principle cleat orientation (down dip). A sanstone ledge has been hard enough to cause problems. Except for the grade and relatively frequent joint spacing (5 to 10 ft) the site would be good to excellent for testing.

Climactically the winters become -45°F with up to 6 ft of snow. The falls and springs are wet and slippery. The pits are exposed to high winds. Climactically the site would be lousy for testing other than the summer, late spring or early fall.

Comments on I/B

Comments from the impact breaker design review follow:

- Screw conveyors are viewed as a high maintenance problem, creates too much dust.
- The spacing of the impact breakers may be critical - they may need to be adjustable for each lithology or pass.

- A power take off of a Cummings engine was viewed favorably.
- The I/B system should fit in with a truck-shovel operation best.
- They were concerned over the cut height flexibility especially considering seam height variations.
- They thought spades were better than bull pricks.
- They were concerned that the unit be able to traverse 20 percent grades (not including local irregularities).
- Considering the grades encountered, the spectre of high tipping moments as noted, especially with the extended transfer chutes.
- Should be good for parting removal - they saw a real need. It would be well worth it if the unit could simultaneously split out thin (3 to 6 in.) riders from partings.
- The cutting head should be capable of cutting below or above grade.
- The transfer chute idea was okay. They saw it as dropping windrows rather than direct loading. They use end dumps rather than bottom dumps.
- They thought we would be forced to go to track rather than rubber tired (Easi-miner worked well).
- The unit should be capable of sumping into corners, and operating in both directions.

- Could see a use for water trenching. - The Easi-miner was so utilized.
- The Easi-miner had lots of hydraulic problems in particular in the winter. They emphasized that any vehicle - including the testing - must be winterized.
- Noise may be a problem.
- Should determine the wear on the impactors.
- The I/B may have too much horsepower.
- Must look at availability of continuous use.
- Asked whether we had investigated mechanical cam action impact breakers such as the kent tools.
- They liked the Holland Loader in the Shirley Basin, however, if one Cat was down, the whole unit is inoperable.
- Could be used as a clean up tool, partings haulroads, ramps.
- Liked small unit rig, not larger version.
- Teeth change for the Easi-miner was 4 hours - what would be maintenance time on the I/B?
- Should produce 10,000 tons per day (TPD) in coal, 10,000 yd³ per shift in overburden.

Geology

The Trapper mine is located along the northern flank of the Williams Fork Mountains, forming the southern limb of the east-west striking Sand Wash synclinatorium (or the northern limb of the Williams Fork anticline, or the southern limb of the Big Bottom syncline). The crest of the mountains forms the southern property boundary. Four seams are presently mined H, I, Q, and R, all belonging to the Williams Fork formation of Cretaceous age. The upper H and I seams are only present in the northern portion of the property. Thicknesses are 5 to 9 ft respectively, characterized by 10,100 to 10,200 BTU's, .45 percent S, 16 percent moisture, 10 percent ash. Roughly 40 ft of sandstone and shale separate the H and I seams. The Q and R seams are mined in the southern section of the property and are 100 ft below seam I. The Q seam ranges in thickness from 8 to 13 ft with a 1 ft shale parting near the top, and the R seam splits in to $R_1 = 3$ ft and $R_2 = 2$ ft. The R parting can reach up to 10 ft thick of shale and siltstone. Seam separations of the R and Q seams varies from 40 ft up dip, thinning down dip. The R and Q coal is characterized by 9,600 to 9,900 BTU's. The coal is blended at the power plant. The average slope of the surface is 10 percent while the seams dip at 16 percent, with local rolls of up to 20 percent. Stripping depths vary according to the local geology but ranges from 20 to 150 ft. Several deeper seams are being considered for underground mining. Fracture evaluation was difficult as UI uses a 200 ft blasted buffer zone along the highwall. Pit floors are fireclay.

Pit Layout

All three pits follow the same basic pattern. Topsoil is removed 600 ft ahead of the dragline operation. Topsoil varies from 8 in. to 6 ft, averaging 2-1/2 ft. Two Joy RR10 overburden drills mounted on Cat D9 tractors drill 10-5/8 in. diameter holes. The schedule calls for 4,500 ft of hole every third day. Hole depths vary with location down to 140 ft. Trapper buffer blasts behind 200 ft of previously blasted overburden (no free face) to protect the dragline. Powder factors are .4 to .5 pounds/ton

(lb/ton) for coal, .3 to .35 lb/ton shallow overburden, .07 lb/ton deep overburden. Although the burden can be ripped by a D9, they don't like to. Coal drills are Joy dual booms, drilling 4 in. diameter holes at a 12 x 12 ft spacing.

The draglines are all Page 752R's downrated from 42 yd³ to 30 yd³, in able to get a 305 ft boom or 285 ft reach from the centerline. The draglines operation off of the highwall working down dip. In the Ashmore and Enfield pits, the dragline dead heads up dip and excavates down dip when taking the interburden. In the longer Derringer pit, the dragline works up dip and down dip. The draglines mine out the pad down dip, turn around and mine the previous pad and then move down to the now excavated down dip pad. This box cutting technique makes for a gear tooth shaped highwall. The dragline works in area 600 to 700 ft long, or 300 ft down dip and 300 ft up dip (see Figure 1).

In the Derringer pit a parting between seams wedges from 40 ft up dip to 10 ft at the lower end of pit. The parting is blasted and removed by hydraulic excavators, and truck. When a 300 ft block of coal has been exposed it is removed (measured up dip). Another 300 ft thick block of parting is blasted and pushed via dozer into the down dip pit. This continues up dip until the parting thickness reaches 25 ft (sometimes only 10 ft). The dragline then walks over to the spoil side, builds out a pad and removes the parting working up dip.

Coal loading is accomplished by three Demag III 15 yd³ hydraulic excavators, operating off of the coal. They load into four 50 ton Mack 45 Sx end dumps, seven 50 ton R50 Euclids, or two 70 ton Wabco's, running on the floor. Two 24 yd³ Terex scrapers remove topsoil. Ramps are located at either end of the pit and one at midpoint through the spoil in the Derringer pit. Ramp grades are 8 percent and haulroads are surfaced with locally mined red dog.

(PREPARED BY)	(DATE)	(REPORT NO.)
(CHECKED BY)	(DATE)	(PROJECT)
TITLE		

Fig. 1 Trapper Move

- Dragline located on pad A
- Strips out box ①, removes previous pad ②
- Moves ③ to pad B, cuts out box ④ removes pad A ⑤

M E M O R A N D U M

TO: A. Fisk

FROM: A. Mangolds
R. Simpson

SUBJECT: Mine Visit to Rosebud Mine

DATE: 10 January 1980

Rosebud Mine

Western Energy Co.

Colstrip, MT 59323

406-748-2326

(approximately 1/2 mi. S.W. of Colstrip,
approximately 100 mi. E. of Billings)

Contacts: "Spec" Willis, Mine Superintendent, Long Construction
Co.

The Rosebud mine is operated by Long Construction Company, owned by Western Energy Fuels, a subsidiary of Montana Power. The coal is shipped primarily to the nearby Colstrip power units, the Corette plant, and several midwestern utilities in Minnesota, Wisconsin and N. and S. Dakota. The Rosebud seam of the Fort Union formation (Cretaceous) is the only seam mined. It averages 22 to 24 ft thick, and is characterized as 8,700 BTU, 25 percent moisture, 9 percent ash, .8 percent S. The overburden averages 100 ft thick, is primarily soft to medium hard, siltstones, sandstones with some shale.

Our interview was with "Spec" Willis, mine Superintendent of Long Construction Company. His background is large earth moving projects, which he perceives open pit mining to be. Spec was respectfully cooperative although any real power is wielded by the management of Western Energy in Billings. Spec gave us a detailed rundown of the operation, however we did not get a guided mine visit. Arrangements must be made with Western Energy, and due to our time limitations were not able to do so. Spec indicated that he would not be happy with a test program in his pit. However he didn't seem to be the vindictive type. Cooperation wise, Rosebud could be classified as moderate.

The mining operation at Rosebud is severely limited by permit restrictions. The operation is split up into three pits, two using 60 yd³ draglines (BE8050's), backed up by a Marion 360 (pits A, E), and a scrapper stripping operation (pit B). The pits move quickly inferring that test times would be short. Highwalls were 100 ft to 270 ft high, 1:1/4 slope, haul roads spaced through the spoil. Finding a location to run a test in coal would be difficult, however outcrops in the form of low ridges could be used for overburden tests. In terms of interfacing with the present operation, Rosebud would be a difficult to moderate location. The overburden appears to be relatively soft. Few fractures and boulders exist. All of it can be ripped however it is blasted. From the very little that we saw, the strata was continuous and thick. The rock appeared to decompose or break up rapidly after blasting and handling. Geologically this should be an 'easy' test site.

Comments on the impact breakers concept were:

- Material transport would be difficult. Hard to beat the dual function of the dragline.
- The machine must be capable of cutting below grade.

- The machine should be capable of operating in the corners.
- Interested in seeing what the traction-thrust behavior would be in wet fine clay.
- Liked rubber better than track.
- Needed to be flexible in cutting height.
- Probably no good in the overburden.
- Possibly of use in coal, especially when partings were present.
-

Geology

The coal is Rosebud seam, 22 to 24 ft thick, no parting, flat lying. Overburden 100 to 270 ft high, average 100 ft, of soft to medium hard sandstones, siltstones and shale. Close inspection was not possible, however the contacts appeared to be gradational, varying $\pm$ 10 ft over 3,000 ft pit length. Outcrops contained isolated hard shale lenses, 10 x 2 ft. Isolated sandstone ridges raise overburden heights to elevations greater than 100 ft. No significant cleat or jointing was visible (spacing 5 to 20 ft). A 30 to 40 ft thick shale-'sandrock' cap-rock overlies the coal, and a fireclay floor becomes slippery when wet.

Pit Layout

The Rosebud mine has been segmented into three pits (A, B, E) due to permit restrictions. Pit lengths are limited to roughly

3,000 ft, chevron shaped. Overall stripping ratios are 3.5:1. Two of the pits (A and E) are dragline pits, while the third uses a new concept of stripping scrappers. The operations run 7 days a week, 3 shifts.

Pits A and E are the highest producers, using two Marion 8050 draglines with 60 yd³ duckets. Boom lengths are 325 ft, and they load 4,000 yd³/hr on the average, 5000 yd³/hr on a good day. An old Marion 360 helps out at the E pit, while a BE 1050, 24 yd³ bucket helps at pit A. Pit floors are 170 to 250 ft wide. 20 ft of coal is often left at base of the spoil to act as a fender reducing recovery to 90 percent. Haulloads extend through the spoil.

Pit A uses a BE280B loading shovel, pit E uses a BE550, and pit B uses a BE250B behind the scrapper operation. The loading shovels have 17 yd³ buckets, although Spec requested 22 yd³. Coal is taken in a single pass (no lifts), at a rate of 1000 tons per hour (TPH). Tipple capacity is 4,000 TPH. No requirements or problems exist with coal size. Primary (roll?) crushers take the coal down to -3 in. The coal is loaded into 13 120 ton bottom dump Euclids, two Cat 660's, and one Cat 666. Conveyors were considered, however a German firm said that the environment was too abrasive. Tire life is apparently very short lasting, an average of 600 hours.

Overburden is shot with two BE60R, and one BE45R. Holes are 15 in. diameters, burden 35 ft, spacing 40 ft all shot with ANFO. The burden ratio was .35/100 yd O.B. Three failing rigs, drilling 6 in. holes are used for coal. All of the burden can be ripped, although a shale caprock is marginal.

Pit B is presently using a scrapper stripping technique with four cat 637D tandem powered push pull scrappers, and two D&H dozers. The pit is up to 160 ft deep, 1,300 ft long, and 150

to 200 ft wide. The dozers create a haul ramp, the scrapper teams run down the ramps, picking up their load, and continue across the pit to dump in the reclamation area. Cycle times are 3-1/2 to 4-1/2 min, moving 260 to 280 yd³.

Western Energy Co.

North Western Resources Co.

404 N. 31st St.

Billings, MT 59101

406-252-2277

Contacts: Roger C. Rice, V.P. Resources
Tim Wood, Manager - Planning.

Spec Willis had suggested we talk to Art Niel at Western Energy. Mr. Niel is in charge of production and would have ultimate say over permission for testing. Mr. Niel was not in so we talked to Mr. Rice and Mr. Wood. We reviewed the project with them. Their comments paralleled Specs. They thought diesel costs would be high, especially with the additional trucks required for overburden handling. They thought it had potential in thin seam mines, mines with partings, and shovel-truck operations. They could not see how it could be used at Rosebud or even tested at Rosebud due to the short pit lengths. They would talk with Art Niel. There was a possibility of using it at a smaller mine such as at Grass Creek, MT.

Subsequent telephone conversations were that Art Niel couldn't see 'why they should bother', but would talk to us personally if we wanted. No further action taken as of 9 January 1980.