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✓ DOE/PC/30155-T1
(DE82009824)

**MONITORING THE BLIND SHAFT BORER PROJECT, OAK GROVE,
ALABAMA**

Final Report

**By
Ray Amstutz
Tom Danowski**

March 1982

Work Performed Under Contract No. AC-22-80PC30155

**Williams Brothers Engineering Company
Tulsa, Oklahoma**



U. S. DEPARTMENT OF ENERGY

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**FINAL
REPORT**

**MONITORING THE
BLIND SHAFT BORER PROJECT
OAK GROVE, ALABAMA**

prepared for
**UNITED STATES DEPARTMENT OF ENERGY
DEPARTMENT OF FOSSIL FUEL
Carbondale, Illinois**

Contract DE-AC22-80PC30155

March 1982

WILLIAMS BROTHERS ENGINEERING COMPANY



A Resource Sciences Company

RESOURCE SCIENCES CENTER • TULSA, OKLAHOMA 74177

ABSTRACT

In 1974, plans of the United States to obtain energy self-sufficiency included a significant increase in coal production, primarily from new underground mines in the Eastern states. The poor condition of coal shaft sinking companies was a major concern. The U. S. Bureau of Mines perceived similarities between shaft sinking and tunnel boring and felt that a machine could be produced for faster, safer shaft sinking.

In January 1975, the Robbins Co., a major producer of tunnel boring machines, submitted an unsolicited proposal to the Bureau of Mines to develop, design, build and demonstrate a Blind Shaft Borer (BSB). In June 1975, a contract was initiated to start work on a BSB. After the Department of Energy was formed, the project was transferred to their Department of Fossil Fuel. In late 1978, while the BSB was being assembled for the field trial near Oak Grove, Alabama, the DOE contracted with Williams Brothers Engineering Company to monitor the site activities and provide technical advice to the Technical Project Manager.

This report reviews the BSB project prior to the field trial, describes field trial operations as observed by Williams Brothers Engineering Company personnel and provides a summary of daily activities. It also details project problems, interim efforts to resolve them, results obtained and recommendations to preclude their re-occurrence on future BSB projects.

FOREWORD

This report was prepared by Williams Brothers Engineering Company, Tulsa, Oklahoma, 74177, under DOE Contract Number DE-AC22-78ET10043. The contract was administered under the direction of Mr. Timothy Zeigler and the Technical Project Manager, Mr. Gary Jernberg. Mr. Louis J. Ruzzi was the Contracting Officer. Mr. Paul Sands, Bureau of Mines, Spokane, Washington, provided technical assistance and was the Technical Project Manager of the Blind Shaft Borer Contract between the Robbins Company and the DOE.

This report is a summary of the work completed as part of the DOE contract with Williams Brothers Engineering Company during the period November 1978 to September 1981.

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ROLE OF WILLIAMS BROTHERS ENGINEERING COMPANY
IN THE BLIND SHAFT BORER PROJECT

During the mobilization phase of the Blind Shaft Borer at U. S. Steel, Oak Grove field trial site, the DOE contracted with Williams Brothers Engineering Company (WBEC), Tulsa, Oklahoma, to monitor and evaluate the BSB project.

The objective was to have WBEC assist the Government Technical Project Manager (TPM) by observing and assisting the field trials of the Blind Shaft Borer being conducted by The Robbins Company under DOE Contract ET-75-C-01-8897.

The services provided by WBEC were to include maintaining a daily log, overseeing the collection of data, participating in project review meetings, coordinating visits by interested parties, following the resolution of problems arising during the operations and serving as technical advisor to the Technical Project Manager.

Some of the WBEC contractual requirements were to monitor the entire cross-section of operations with priority given to those where problems were experienced. A "Problem Book" was to be maintained providing a detailed description of all problems (operational and potential), the interim solutions attempted, final solution and recommendations for future improvements as required. WBEC was to report verbally to the Government Technical Project Manager (TPM) at a frequency required by the circumstances at the field trial site and by the TPM. Following the end of the contract, WBEC was to deliver the "Final Report," "Problem Book" and the "Project Log Book."

INTRODUCTION

In October 1978 Williams Brothers Engineering Co. entered into a service support contract with the Department of Energy. The contract required Williams Brothers Engineering Co. to monitor the field trial of the Blind Shaft Borer (BSB) built by the Robbins Co. of Seattle, Washington. The field trial involved boring the No. 4 ventilation shaft of U.S. Steel's Oak Grove Mine west of Birmingham, Alabama.

While monitoring the field trial of the BSB and its supporting equipment Williams Brothers Engineering Co. was to evaluate the progress and assist the government's Technical Project Manager in making technical decisions to improve the system. Williams Brothers Engineering Co. monitored the field trial beginning in November 1978 while the BSB was being mobilized in the shaft collar and continuing through October 1980 when the BSB had been removed and the surface support equipment was demobilized.

Serious and continuing problems were encountered with the primary mechanical muck pickup system. The DOE had a concurrent contract with Radmark Engineering, Portland, Oregon for development and testing of a pneumatic hoisting system to replace the skip hoist. This contract was expanded to include investigation and possible testing of a vacuum muck pickup system. In early 1980, the DOE requested that Williams Brothers Engineering Co. monitor the vacuum pickup tests and evaluate the system for possible application on the BSB.

The following three reports were required upon completion of the contract:

Final Report
Project Log Book
Problem Book

The three reports were combined into one report, thereby eliminating the duplication of material that would have been required in three separate reports. The Project Log Book and Problem Book are included herein.

The Final Report provides an objective reporting of events throughout the BSB field trial. It includes information on the history of the BSB project, the companies involved, the BSB and its support equipment, the field trial site and the investigations by Radmark, Inc. into alternative methods of removing the muck (broken material produced by the BSB) from the shaft. It provides a brief overview of significant events and major problems which are covered in more detail in the Project Log and Project Problems sections.

The Project Log is a factual summary of significant events as recorded in daily reports written by Williams Brothers Engineering Company personnel during the field trial. A section is also included which covers the daily activities during the testing of the Radmark vacuum pickup system in Seattle, Washington. Both sections are arranged in chronological order.

The Project Problems document actual operational problems, the solutions attempted during the field trial with the subsequent results, and recommended solutions to further improve the BSB

system. It includes potential problems, recognized during the field trial, and recommended solutions. The problems also include those observed while monitoring the Radmark vacuum pickup tests. The recommended solutions were incorporated into the design of a modified BSB; however, in several areas, the choices were not clear-cut, and a second modified design showing viable alternatives is also included.

The Project Problems cover a considerable range of severity. The problems are arranged in subject areas, with the most important subject areas shown first. Within each subject area, the individual problems are arranged so that the most severe operational problems are shown first.

SUMMARY

Williams Brothers Engineering Company monitored the Blind Shaft Borer (BSB) field trial conducted near Birmingham, Alabama, and the testing of the vacuum muck pickup system in Seattle, Washington.

The BSB, built by The Robbins Company, Seattle, Washington, and operated by the Cementation Company, Tucson, Arizona, was funded originally by the U. S. Bureau of Mines and later transferred to the DOE.

The field trial began in 1978 and problems were immediately encountered with the primary muck handling system. This problem continued throughout the life of the project. The components were kept in operational condition, but performance approaching that of the test unit was not maintained.

Additional problems arose with the machine, many of which extended the time the BSB was working in the shaft considerably beyond the anticipated schedule.

One problem that hampered overall performance was the inability to complete the lining cycle in the time scheduled.

The high volume of water required to keep the muck handling system operational was not considered in early planning and design. It overwhelmed the muck disposal system and waste water treatment facilities.

The low performance of the BSB eventually pushed the shaft completion date beyond that which could be accommodated by U.S. Steel's Oak Grove mining plan.

To avoid creating operational problems for the mine, the BSB was demobilized and the shaft completed by conventional means.

An alternative to the mechanical muck system was investigated and successfully tested, but the results were not obtained in time for retrofitting the BSB.

SECTION 1

1.0 PROJECT HISTORY

In the mid-seventies there was a rising national awareness that our energy consumption was greatly exceeding domestic production. The subsequent need to import more oil left the nation subject to the whims of the producing countries.

As part of the planning to achieve energy self-sufficiency there was a programmed increase in coal production from the then current 600 million tons per year to one billion tons in 1983. Of this increase, 60 percent was expected to come from underground mines in the Eastern states.

The Bureau of Mines in studying the impact of this production increase concluded that there were several serious shortcomings. One of the major concerns was the increased need for coal seam access (new shafts) and poor condition of the shaft sinking industry. The coal mine shaft sinking companies in general were using obsolete equipment and finding it difficult to provide sufficient incentives to maintain a quality work force.

The Bureau perceived some similarities between shaft sinking and tunnel construction and felt that application of Tunnel Boring Machine (TBM) technology to shaft sinking could improve both the efficiency and working conditions. Higher shaft sinking rates, minimal exposure of men to unsupported ground, and a reduced workforce were realistic goals for a shaft boring machine.

1.1 Advantages of Boring Shafts

The advantages of boring shafts are manyfold. All contribute to the faster, safer and more economical sinking of coal mine shafts. A bored shaft provides a strong, circular cross-section with a minimum of overbreak. The reduced overbreak minimizes the amount of rock to be hoisted and the volume of concrete required for the lining. Also, boring instead of blasting disturbs the wall rock less, improving safety, reducing, and in some cases eliminating lining requirements.

The safety should be enhanced by a smaller work crew, no explosives used past sinking of the collar, and minimal exposure of the crew to unstable shaft walls.

A shaft borer should be faster and provide good shaft alignment.

The improved work environment should increase worker productivity and reduce the problem of maintaining a qualified work force.

The per foot cost of a bored shaft should approach that of a conventionally sunk shaft, but the real economical advantage of shaft boring must arise from a quicker completion, allowing earlier access to the coal seam. The earlier access will allow production to start sooner, providing an improvement on the overall return on investment.

1.2 National Need for the BSB Project

In January 1975, The Robbins Company (TRC) Seattle, Washington, submitted an unsolicited proposal to The Bureau of Mines to develop and demonstrate a Blind Shaft Borer. TRC is a leading manufacturer of tunnel boring machines, with several machines

successfully working in rock formation comparable to those a shaft boring machine would have to penetrate. TRC felt that existing TBM technology could be applied to a shaft borer, and the principal problem would be to restructure a TBM to a vertical mode of operation. The proposal was technically evaluated with the conclusion that it offered an innovative and unique concept of sinking coal mine shafts. On the basis of this evaluation, the USBM procurement office was given authorization, in February, 1975, to fund the Blind Shaft Borer project. The contract was negotiated in April, 1975, at the USBM in Denver, Colorado. Representatives in attendance of the negotiation conference were Richard Robbins, President of The Robbins Company, Thomas Crocker, USBM Technical Project Officer and George Honold, USBM Supervisory Contract Specialist. As a result of the negotiations, it was recommended that a contract be awarded to The Robbins Company.

1.3 History of the Development of the Shaft Boring Program

In June, 1975, The Robbins Company, entered into a cost-sharing contract with The USBM to develop and demonstrate a Blind Shaft Borer. The work was divided into four distinct phases.

Phase I - Preliminary design and feature testing; Phase II - Shaft Borer fabrication and site preparation; Phase III - Full-scale demonstration; and Phase IV - Final Report.

It was desired to develop a machine capable of boring a 20 to 24-foot diameter coal mine shaft to depths of 1,800 feet at a cost competitive with conventional methods.

The shaft borer and ancillary equipment was designed to provide a machine that is capable of:

- o Boring a 20 to 30-foot diameter shaft in typical coal mining geological formation in a single pass.
- o Penetrating at the rate of 3 to 5 feet per hour with an average sinking rate of 10 to 15 feet per shift.
- o Having an average utilization ratio between 35 and 55 percent with a theoretical design ratio of 90 percent.
- o Allowing cutters and cutterhead to be inspected and repaired without placing personnel in hazardous locations.
- o Operating with a minimum number of personnel underground, preferably no more than six.
- o Operating with no personnel exposed to unsupported ground.
- o Injecting grout ahead of the face in water bearing zones.
- o Providing progressive installation of the shaft lining and/or ground support.
- o Conforming regulations defined by MSHA and the Coal Mine Health and Safety Act of 1969.
- o Being easily transported between projects and quickly assembled and disassembled.

The Robbins Company was authorized to develop and document preliminary design concepts and conduct trade-off studies.

The concepts were to be documented by layout drawings describing major components and principles of operation, preliminary specifications for the structural, mechanical, electric and fluid systems; description of the required surface equipment and facilities; details of the transportation, mobilization and demobilization operations.

The elements of the trade-off studies were to include:

- Cutterhead subsystem
- Primary muck removal subsystem
- Secondary muck removal subsystem
- Ground support subsystem
- Surface facilities
- Costs (purchase, operation, and maintenance)
- Operating performance (instantaneous and sustained rates of advance as a function of geological conditions and rock types in coal mining regions)
- Equipment reliability
- Personnel safety

The Robbins Company was to select a primary and alternate system design for further evaluation based on the results of the trade-off studies.

During the investigative studies three machine design concepts were evaluated:

- a. Two variations of a plunging head, each having axis of rotation normal to the shaft.
- b. Twin cutterheads, their axes of rotation parallel to the shaft axis and advanced in helical fashion.
- c. A full face borer with cutterhead axis of rotation parallel to the shaft axis and either mechanical or pneumatic (vacuum) muck removal.

For all of the concepts, mechanical muck systems involved bucket elevators lifting the muck up to a hopper(s) from which it loaded into a skip for hoisting to the surface. The bucket elevator lifted from the face, with the exception of the plunging head concepts, where the cutterhead lifted the muck to a transfer point near its axis of rotation.

The pneumatic (vacuum) was proposed as a viable alternative to the bucket elevator on the full-face borer.

The Robbins Company concluded that a full-face borer with a mechanical muck pickup system offered the highest probability of success. The alternate system design was again the full-face borer with a pneumatic (vacuum) for the first stage of muck pickup. Both designs were quite similar to a Robbins' tunnel borer stood on end, with the exception of the muck handling systems. It was noted that the muck handling system required additional testing, and that a pneumatic (vacuum) alternative should be further investigated.

The Phase I preliminary design utilized two bucket elevators in combination with scrapers to clean the face and two skips to hoist the muck to the surface. All functions on the BSB were powered from an electrohydraulic power unit located on the surface with fluid routed to the BSB through a pair of 6-inch rigid pipes (one pressure, one return). The BSB was to bore a 24-foot diameter shaft using 1,050 HP with instantaneous rates up to 2.5 feet per hour. The full-face cutterhead was to utilize 54 disc type cutters and rotate at 0-2 rpm. The estimated weight was 250 tons and the BSB was capable of 1.2 million pounds of thrust along with 1.2 million lb./ft. of rotational torque.

In May, 1976, during the latter stages of Phase I, a presentation was made to industry which ultimately brought about

some design changes. The cutterhead drive was switched to electric motors from hydraulic motors, which brought about the introduction of two-speed gearboxes and air clutches. The electrohydraulic power units were relocated from the surface onto the BSB. The belt-driven bucket elevators were converted to chain drive in an attempt to improve bucket tracking at the face.

In July, 1976, The Robbins Company received a contract from the U. S. Bureau of Mines to design and construct a Blind Shaft Borer (BSB), suitable for the construction of a 22-foot finished diameter (nominal 1-foot concrete lining) coal mine shaft.

To allow more room for guidance errors, the BSB cutterhead gage diameter was increased to 24 feet 5 inches, ensuring that the 22-foot I.D. of the concrete liner and nominal one-foot wall thickness could be maintained.

A guidance system utilizing two self leveling lasers directed through 5-inch pipes embedded in the concrete liner 180° from each other was selected.

A request for quotes on a vacuum primary muck pickup system was sent out with the following critical specifications.

- A. 95 cubic feet per minute (cfm) of muck
- B. Muck conditions ranging from dry to super-saturated with occasional five-pound pieces.
- C. Muck density ranging from 110 to 150 pounds/cubic foot
- D. Vertical suction lift of 55 feet

In September, 1976, the bucket elevators were redesigned for conversion from mounting on a belt to mounting on a chain and for reduction of the tail pulley diameter to improve the

bucket angle of bite in the muck furrow. The entire scoop assembly feeding muck to the bucket elevators was also redesigned. This redesign was primarily initiated because the bucket elevators needed a quantum improvement if they were to reach the design goal of 50 cfm of muck.

Replies were received from two pneumatic equipment manufacturers stating that 95 cfm under the specified conditions was unrealistic and impractical.

The testing of the mechanical muck system continued with a best performance of 8.4 cfm with two bucket elevators. Numerous cutter and scraper arrangements, some of which deviated from the earlier eight-spoke arrangement, were laid out, but none were totally satisfactory.

The capability of test fixtures to handle muck was significantly improved to 19.5 cfm in November, 1976, as a result of the previously mentioned revisions. Investigation of additional mechanical muck handling concepts was started because the bucket elevators did not appear capable of digging and lifting 50 cfm of muck from the face. One concept involved using a drag chain to move muck inward and up from a pick-up point at about a six-foot radius and dump the muck into the bucket elevator above the center height of the tail pulley.

In December, 1976, an adaptation of a "Dosco" flight conveyor was designed for use as the primary muck pickup from the face. It loaded the bucket elevators which were to lift the muck to the skip loading hoppers.

During January, 1977, the design of the BSB continued and a request to convert the muck test system to the Dosco flight conveyor and bucket elevator combination was made. The design of the BSB upward from the main bearing and bull gear

area was not affected by the requested muck system changes, and work in those areas continued. The bucket elevators obtained a pickup rate of nearly 30 cfm on two occasions in January, 1977.

In February, 1977, the stroke of the BSB propel cylinders was changed from 18 inches to 30 inches. A visit was made to observe a Dosco flight conveyor in operation to determine if application to BSB appeared feasible, and the trip report was positive. The test fixture was torn down and relocated in preparation of testing a muck handling system made up of one flight conveyor and one bucket elevator. Single units were used for testing to minimize problems, assembly time and costs.

During March and April, 1977, the muck handling test fixture was being rebuilt. The initial core hole was started at the proposed shaft site and a petition for a variance to Title 30 for the use of a non-permissible transformer downhole was prepared.

In May, 1977, muck handling tests resumed and after eliminating start-up problems, the single flight conveyor bucket elevator system handled over 25 cfm of muck which was doubled (50 cfm) to estimate the performance of two flight conveyor-bucket elevator systems working in parallel on the BSB. The average of the muck handling tests working with a variety of muck conditions was closer to 15 cfm for a single system or 30 cfm for two systems in parallel.

The muck handling tests continued in June and July of 1977 with modifications to the conveyor paddles and the use of a coarser grade of muck (rock). Again, some tests were better than 50 cfm, but the average was closer to 35 cfm when all test conditions were considered.

During August, 1977, the interface between the flight conveyor and bucket elevator was determined to be a bottleneck, and the flight conveyor was repositioned and the chute steepened. Subsequent tests during August, September, and October showed results of 50 to 100 cfm. This range may seem excessive, but it reflected the difficult nature of simulating operation of a BSB mucking system and acquisition of meaningful data. When the tests were conducted on the basis of picking up muck for a fixed time and subsequently measuring the volume, the average rate ranged from 77 to 82 cfm. When the time was measured to pick up a given volume of muck, the average rate ranged from 51 to 55 cfm. The latter method indicated that testing in a closed system lead to a reduced volume of muck available for pickup when the bucket elevator discharge was collected for measurement. Pickup of a smaller fixed volume should have produced results more in line with the fixed time tests.

Tests were conducted with muck and water with a water content of 42 percent by volume (22 percent by weight). The test results indicated bucket elevator speed was more critical for the soupy material as it would flow from the buckets at the top before reaching the discharge point. The test data, when corrected to a dry muck equivalent for estimating BSB penetration rate, was only 8 to 24 cfm. The lower bucket elevator speed produced the lower volume due to premature dumping.

During November, 1977, the testing of the muck system was completed. An endurance run of 135 hours, using a mixture of coal, clay and sandstone, was conducted. Measurements were made of critical parts, and no severe wear was found nor were there any failures during the test. The endurance test led to changing scraper angles and relocation of two cutters on the BSB cutterhead design. The assembly of the BSB continued

as components were available and the front and rear shield were assembled.

In January 1978, the BSB design was completed but the assembly was halted to allow accumulation of components. The whole project was being delayed because of the UMW strike, and efforts were made to conserve funds.

The contract between U. S. Steel and Robbins for construction of the shaft was finalized in early February, 1978, and signed by U. S. Steel in early March, 1978. The fabrication and assembly of the BSB and supporting components continued with a possible MSHA inspection of the BSB slated for the middle of May.

Activity at the site began in April. Details can be found in the section on Site Preparation.

The assembly of the BSB continued and the MSHA inspection was done the middle of July, a month after it was ready. MSHA found only minor problems which were easily rectified.

After the MSHA inspection, the BSB was dismantled for shipment to the Alabama site with the last truck load of components leaving Seattle August 21, 1978. The assembly of the BSB is covered in Section 3 of this report.

1.4 BSB Project Equipment and Facilities Description

The BSB project equipment consisted of the BSB machine, downhole support equipment and surface support equipment.

The BSB machine did the actual rock cutting and initial muck handling. The downhole support equipment consisted of the gallows, 1250 KVA 7200/950 volt transformer, and the steel

forms for concrete lining the shaft. The surface support equipment consisted of the headframe, guidance lasers, hoist house, skip hoisting system, man and materials hoist, galloway support winches, work shops, air compressors, ventilation fans, standby diesel powered generator, emergency hoist, power cable support winch, lighting power cable support winch, boom truck, dump truck, and front end loader.

The BSB machine can be separated, for discussion purposes, into non-rotating components (Figure 1) and rotating components (Figure 2) that rotate with the cutterhead.

The cutterhead was equipped with 56 back-loading, 13-inch disc cutters. Twelve of the cutters were mounted in 3 quad assemblies at the cutterhead center. The BSB shaft excavation diameter was 24 feet, 5 inches with a new gage cutter. A cross-section through the center of the shaft would show the profile of the face to be a very flat "w". This profile, shown in Figures 1 and 2, had its lowest point at a radius of 5 feet, 9 inches. Inward of the low area, the face would appear as a cone with a height of 8 inches. Outward from the low area, the face gradually rose to 8 inches at a radius of 10 feet, 6 inches. From a radius of 11 feet, 6 inches to the gage cutter at 12 feet, 2-1/2 inches, the face rose steeply. The gage cutter was 29 inches above the low area. This steep area of the face was self-cleaning by the action of gravity. The face inside a radius of 11 feet, 6 inches was relatively flat, below the angle of repose for the muck, so the muck had to be moved by a series of scrapers into a furrow at the low point.

The primary muck pickup consisted of two diametrically opposed single chain flight conveyor bucket elevator systems. The flight conveyors were mounted in the cutterhead and positioned to pick up the muck furrow formed by the scrapers

in the low area on the face. The flight conveyor picked up muck as the rotation of the cutterhead swept it through the muck furrow and conveyed the muck up a 50° slope to where it discharged at the tope of the chute which, in turn, fed a bucket elevator.

The two bucket elevators rose through the inner tower (all rotated with the cutterhead). Chain mounted polyethylene buckets lifted the muck from two feet above the face to 49 feet where they dumped into the carousel (an annular collection hopper). Paddles connected to the rotating structure drug the muck around, discharging it through one of two openings, thereby loading the selected measuring pocket.

Non-Rotating Components

The non-rotating components can be further divided into components that moved down the shaft while boring and those that remained stationary.

The stationary components anchored the BSB to the shaft wall, providing a reaction point for the propel and torque cylinders. The rear shield, grippers, and the structural ring supporting the grippers were the only stationary components.

The non-rotating components that advanced with the cutterhead consisted of the cutterhead support, the front shield, the outer tower and work decks. The weight contributed to the BSB total thrust for penetration.

The cutterhead support:

- o Provided the principal load bearing structure of the BSB.

- o housed the non-rotating, inner face of the main bearing.
- o delivered the thrust to the cutterhead that was required for penetration.
- o provided the torque reaction point between the rotating cutterhead and the stationary gripper ring.
- o received the thrust of the stabilizer cylinders and shoes on the shaft wall, providing directional stability.
- o contained the six cutterhead drive motors, air clutches, speed input gearboxes, and final gear reduction boxes.

The front shield provided temporary ground support from immediately above the cutterhead up to the rear shield. The rear shield extended the protection to a height two feet above the transfer deck.

The outer tower extended upward from the cutterhead support to the top of the machine where the hydraulic swivel and exhaust air swivel were located. The lower section of the tower provided the major support for the muck transfer deck and rose an additional 38 feet above the transfer deck at a diameter of 86 inches. The outer tower provided substantial support for the three upper decks and protected personnel from the rotating inner tower. It also supported the muck measuring pockets, skip loading chutes, and stationary portion of the muck distribution carousel.

The galloway, the major piece of downhole support equipment, was independently suspended from the surface immediately above the BSB and was stationary during boring operations. The galloway served as a work platform and was a support for:

- o stripping and lowering of the concrete shaft lining forms.

- o supporting the dashpots and distribution hoppers for receiving concrete from the two slicklines and directing it into the shaft forms.
- o advancing the shaft service lines.
- o serving as a stationary platform for the non-permissible transformer, which by MSHA regulation could not be moved while energized.

The down-hole transformer was a 1,250 KVA, 7,200-volt to 950-volt unit which permitted use of a reduced size power cable down the shaft.

The shaft lining forms were fabricated from steel and consisted of a curb ring and 30-inch high sections utilized in two, 10-foot lifts to form and subsequently pour 20 feet of shaft lining per cycle.

Surface Support Equipment

The muck hoist, the gallows support winches and the men-and-materials hoist provide direct support to the BSB.

The skip hoist system consisted of two, 120 cubic feet counterbalanced skips capable of handling 40 cfm of muck from a 1,200-foot depth. The hoist was a 1,000-horsepower, double-drum, single-clutched unit which serviced the advancing BSB. The rope length was adjusted every 30 inches of BSB advance, in accordance with the BSB regrip cycle. Scrolls in the headframe and followers on the bottom dump skips permitted automatic dumping on the surface.

The headframe was a simple, although massive, heavy beam structure towering 66 feet above the surface (64 feet plus two feet of collar height). The headframe was designed to

carry the working load of all ropes plus the breaking load of a skip hoist rope, plus the wind load factors.

The man and material hoist was a 165 hp Ottuma single drum unit. The man and material cage was suspended from an independent sheave in the headframe. Crosshead of the cage was guided by the galloway suspension ropes.

The galloway was suspended on ropes from two single drum winches in double purchase. These were New Era Winches with a maximum speed of 19 fpm and used 30 hp motors.

The shaft ventilation was provided by two 36-inch, 100 hp Joy axialvane fans. One was downcast through a 36-inch fresh air duct and nominally supplied 25,000 cfm, while the other exhausted 15,000 cfm through a 30-inch duct, leaving 10,000 cfm upcast in the shaft. An air split from the downcast, through the transformer housing and into the upcast kept the transformer positively ventilated with 1,500 cfm and two inches in water gage positive pressure.

Additional information on the hoist and other surface support equipment can be found in Section 3.

The operator steered the BSB in response to information displayed at the console. Information included the tilt of the BSB, the location of the cutterhead with reference to the theoretical shaft centerline, and a projected location of the BSB if its current attitude was maintained. Electrolytic inclinometers provided the tilt of the BSB, while a pair of diametrically opposed self-leveling lasers (collar mounted) and targets (BSB mounted) provided the location of the cutterhead with respect to the theoretical shaft centerline. A "black box" (hard wired electronics) computed the projected position based on inclination and current cutterhead

position. The operator primarily viewed the cutterhead position display and attempted to minimize the numbers displayed, thus keeping the BSB centered to the theoretical shaft centerline.

The BSB system specifications are given in Table 1.

1.5 Companies Involved in the Project

The BSB project was a multi-faceted project. During Phase 1, the prime government contractor (Robbins) consulted with many companies. Having defined the requirements of the overall BSB system, Robbins proceeded to set up a project team with the required expertise.

The BSB project team consisted of six companies, each of which contributed to specific portions of the project as shown in Table 2.

TABLE 1
SYSTEM SPECIFICATIONS

Blind Shaft Borer

Diameter	24 feet 5 inches
Height	57 feet
Weight	320 tons
Total BSB Horsepower	1055
Designed Advance Rate	40 feet of bored and lined shaft per 24 hour day
Best Achieved Advance Rate	22 feet bored, 20 feet lined in one week
Cutterhead RPM	1.91 or 3.12
Main Bearing	86 inch I.D., Torrington Double Rowed Tapered Roller Type
Cutterhead Profile	4 feet deep, relatively flat 'w'
Cutter Type	13-inch disc, plus 3, 13-inch quad-disc
Number of Cutters	56
Cutterhead Horsepower	750 (Six electric motors @ 125 hp each)
Cutterhead Torque	2.06×10^6 ft-lbs @ 1.91 rpm
Cutterhead Thrust	1.43×10^6 lbs @ 2,000 psig
Average Cutter Loads	25.5×10^3 lbs @ 2,000 psig
Boring Stroke	30 inches

TABLE 1 (CONT)

Hydraulic System Power	4 electric motors @ 50-hp and one @ 30-hp, total 230 hp
High Pressure	to 3,000 psig
Low Pressure	to 900 psig
Electric System -	
Permissible	
Motor Circuits	950 volt, 3 phase, 60 cycle
Controls	120 volt, 60 cycles
Lighting	12 volt, D.C.
Transformer	1250 KVA Capacity @ 950 volts
Muck Pickup System	
Flight Conveyor	2 "Dosco" type to lift first 4 feet
Bucket Elevator	2 @ 40 cfm capacity each, to lift 47 feet
Skips	2 @ 5-ton capacity each to lift up to 1800 feet with 1000 hp double-drum single clutched hoist
Shaft Water System	1 high water level indicator 2 @ 100 gpm Moyno slurry pumps (removed mid-project) 1 @ 100 gpm (clear water pump (2 planned, 1 installed)
Alignment System	2 self-leveling lasers with electronic targets, 2 electrolytic levels, a hard wire logic system, and a digital console display
Methane Monitors	4 each with a 1 percent warning light and 2 percent power interruption

TABLE 1 (CONT)

Ventilation	36-inch intake pipe (24,000 - 26,000 cfm), 30-inch exhaust pipe (19,000 - 16,500)
Instrumented Measurements	
Pressures	27
Displacements	6
Electric Currents	11
Hydraulic Flow-	
Rates	5
Indicator Lights	6
Measurement Equipment in Van (or surface)	Hewlett-Packard 2100A mini-computer Flat Bed Plotter CRT Terminal 9 track magnetic tape drive
Measurement Equipment on Machine	4 Geolographs 2 Micro-Mux Units (data acquisition for Van)
<u>Lining System</u>	
Work Stage	One 3-deck Galloway independently suspended from surface
Forms	20 feet high with separate curb ring
Hanging Rods	11 @ 1 1/8 inch diameter
Concrete Transport	Two 6-inch diameter slicklines with dashpots

TABLE 2
COMPANIES INVOLVED AND THEIR CONTRIBUTION

The Robbins Company	Government Prime Contractor Program Management Machine Design & Fabrication Field Support Contractor to U.S. Steel for Shaft
Cementation Company of America	Principal Operating Sub-Contractor Site Management Collar & Shaft Design Galloway Man Hoist & Man Cage Services to BSB Grouting BSB Operation Shaft Lining Site Work Force
Paul Wier Company	Planning Consultant Site Layout Economic Studies Water Control
Lake Shore Incorporated	BSB Support Systems Design & Manufacture Headframe Muck Skips & Skip Hoist Hoist Ropes & Sheaves Galloway Winches BSB Skip Loading System Skip Loading Controls

U. S. Steel Corporation

Mine Operator

Shaft Site Access

Local Permits

MSHA Regulations

Design Review

Field Support

Battelle Northwest

Data Acquisition & Analysis

Instrumentation

BSB Guidance System

Data Logging

Analyses and Forecasts

Williams Brothers Engineering Company

Monitor of Operations for DOE

Monitor and Evaluate BSB

Field Trial

Monitor and Evaluate Vacuum

Pickup Test

Report on Project Progress,
Problems, Solutions

Monitor Demobilization and
Preservation of Components

BLIND SHAFT BORER NON-ROTATING COMPONENTS

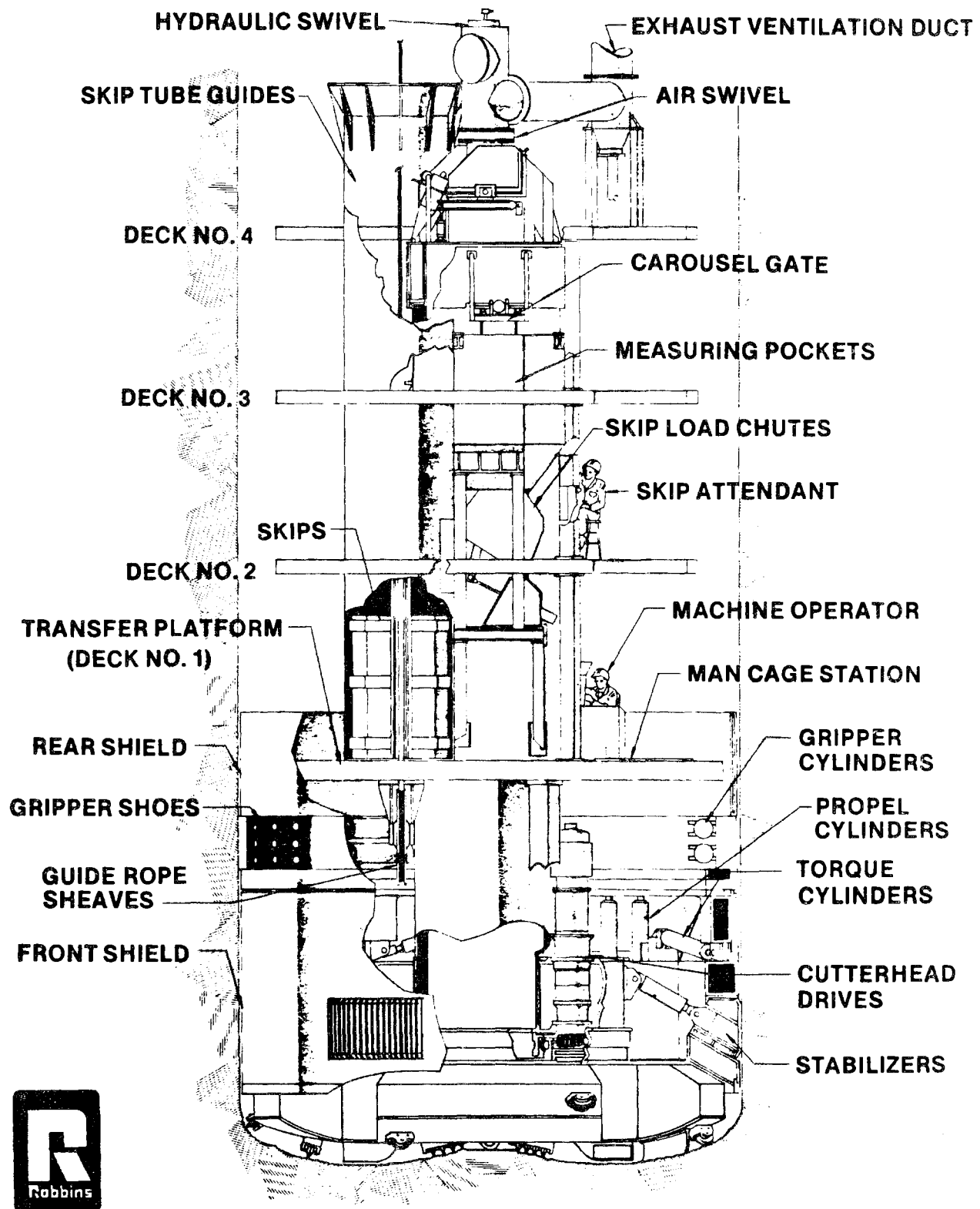


Figure 1

BLIND SHAFT BORER ROTATING COMPONENTS

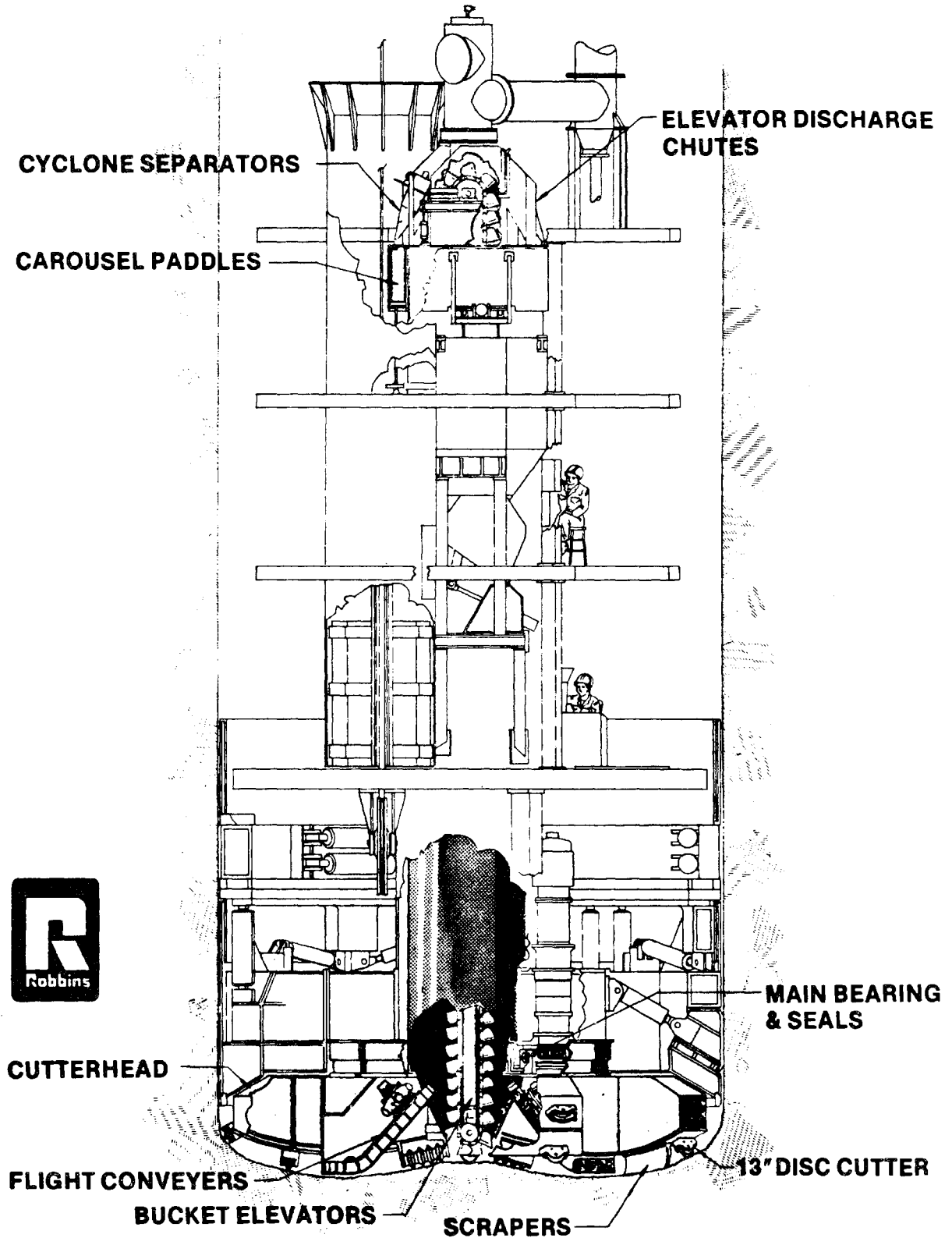


Figure 2

SECTION 2

FIELD TRIAL SITE

During Phase I of the BSB program several coal mining companies and shaft sinking contractors were contacted to determine potential sites for the field trial. The search was narrowed to the Warrior Coal Field of Alabama where shafts are commonly over 1,000 feet deep, and the ground is competent with little groundwater. The area is readily accessible from a major city, Birmingham, and the climate is relatively mild.

The site selected during Phase II was Ventilation Shaft No. 4 of U.S. Steels Oak Grove Mine near Birmingham, Alabama.

2.1 Topography

The Oak Grove mine is located in mildly rolling terrain and the shaft site required considerable earthwork to produce a level work area. The drainage of rain water away from the site was no problem.

The site was situated near a small stream and its junction with an intermittent stream. The stream water was not potable but of sufficient quality for use on the BSB.

The site offered good accessibility to a major city which provided both good sources for materials and ease of access for visitors.

Much of the surrounding area had been contour mined for a outcropping coal seam. This earlier mining had been conducted with little reclamation and the spoil was still sparsely vegetated.

The site was 33 miles from the Birmingham airport and 20 miles from good motel accommodations. The site was connected to a good paved road by an all weather gravel access road maintained by the contractor. The gravel road was 4 miles long and intersected with Mud Creek Road near the main entrance to the Oak Grove Mine.

Figure 3 gives the general location of the site with reference to Birmingham while Figure 4 is a more detailed map of the No. 4 shaft and the existing Oak Grove mine. Figure 5 shows the general layout of the surface plant utilized during the BSB field trial.

2.2 Access Road and Earthwork

U.S. Steel initiated construction by providing an all weather gravel road to the field trial site and in April of 1978 the site was cleared, graded and the muck disposal and drainage areas constructed. The initial drainage areas included a 40-foot by 200-foot settling pond northwest of the shaft. A drainage ditch to carry water pumped from the shaft and water from the skip dump pad was constructed. A small dam was constructed across the draw west of the shaft as reserve capacity and to catch any pond leakage for treatment prior to release into the creek.

2.3 Climate

The climate's influence on a project is greater for a shaft boring project than for a tunnel boring project. On a tunnel boring project the ventilation air is usually conditioned to moderate temperatures before reaching the face, while on a shaft project the travel distance is short, and the air temperature is changed little from ambient conditions on the surface. A

tunnel borer operates in a relatively steady climate while a shaft borer works in a climate that closely parallels surface conditions. The surface conditions should be carefully considered, as they will have considerable influence on worker morale and the quality and quantity of work performed, as well as influencing the performance of borer subsystems, such as hydraulics, electronics and guidance.

The field trial site has a relatively mild climate. The average rainfall is less than 60 inches per year, with October the driest month, 2.5 inches, and March the wettest, 6 inches.

The temperature range is not extreme, with the high and low averages ranging from 90° F to 70° F in July and 54° F to 34° F in January. Only four months, November, December, January, and February, have had a recorded low less than 11° F and only January has had a temperature recorded below zero with a -4° F reading.

During the field trial, the rainfall averaged 1.4 inches per month above normal and set new records in April, 1979, and March, 1980. Rainfall during the first five months of 1980 totaled 18 inches above normal, which greatly increased the problem with the muck ponds.

The temperature extremes during the field trial were a low of 11° F in March, 1980, with a high of 106° F in July, 1980. From the beginning of the project, the average temperatures were close to the historical values, but the spring of 1980 was cooler, with June near normal but July well above average.

The average temperature range from high to low was generally less than 25° F but there were many winter mornings the workers on the BSB would have performed better if the incast

air had been heated. During the hot summer months, cooler incast air would have improved the working conditions on the machinery deck.

Table 3 gives the historical averages for temperatures and rainfall. Tables 4 and 5 give the temperatures during the BSB field trial period.

2.4 Core Drilling

The proposed shaft site was cored in April and May of 1977 to determine if the geological conditions were suitable for a BSB field trial. The results were favorable and additional work was done in October, 1977, to log the hole and determine the grouting required to minimize water inflow into the shaft per U. S. Steel specification.

2.5 Geology

The geology of the shaft site is more critical when a shaft borer is used than when the shaft is to be conventionally excavated. The rock formations must lend themselves to boring. The cutters must be able to break the rock into acceptable sized chips at some nominal advance rate with acceptable wear and cost. The various strata must be competent and not conducive to the production of muck particles too large for the muck removal system. Since a shaft borer is complex, knowledge of the depths and extent of all the water bearing zones to be intersected by the shaft is essential. The inflow of groundwater into the shaft must be controlled if a shaft borer is to be utilized.

The BSB field trial site, Ventilation Shaft No. 4 Oak Grove Mine of U. S. Steel, is located in the Warrior Coal Field.

The field lies in the Warrior Basin district of the Cumberland Plateau section of the Appalachian Plateaus province.

The majority of the economically important coal seams are located in the "Upper Pottsville" or "New River Formation" of the Pottsville Group. This strata is of Pennsylvanian age and consists of soft shales, thin coal beds and a relatively large proportion of sandstone.

The exploratory core hole was spudded approximately 240 feet above mean sea level (MSL). The Lower Bench of the Mary Lee Coal or Brush Creek Coal seam mined at Oak Grove was 4.2 feet thick and located 1,133 feet below the ground surface. Below 25 feet, the rock was unweathered, contained few zones of jointing and bedding planes were relatively tight. The Rock Quality Designation (RQD) values were quite good, with over 80 percent of the rock column rated 100 percent.

Figure 6 shows the Alabama Coal Fields, including the Warrior Coal Field.

A summary of the corehole geological data is given in Table 6. The strata was normally medium hard (MH, 12,000 - 25,000 psi) to hard (H, 25,000 psi and over) with the exception of some shales and siltstones that were medium soft (MS 6,000 - 12,000 psi) and small coal seams classified as soft (S, 0 - 6,000 psi). The BSB in general had an almost ideal geologic location for a field trial with regard to the rock strata.

For a more detailed geological report, the corehole analysis done for the project is recommended. The report is titled, "Pilot Boring and Geological Analysis, Blind Shaft Boring Machine Demonstration Air Shaft No. 4 U. S. Steel Oak Grove Mine Oak Grove, Alabama." The report was prepared by GAI Consultants of Pittsburgh, Pennsylvania, in December, 1977.

2.6 Grouting

Since the BSB is a complex, sophisticated machine with many electrical components, it was decided to conduct a more extensive than normal grouting program. This was done to keep the shaft as dry as possible and to determine whether the extensive grouting program was cost effective. The CHI report recommended carefully grouting the entire length of the shaft because of vertical joints at locations apart from those located by the pilot boring. They stressed grouting above 330 feet and, in addition, the interface between the top of the rock and soil overburden because it was permeable and could produce large quantities of water.

The pilot hole (6-1/8" dia., 9 feet north of the core hole) was the first hole to be grouted. A total of 2,835 gallons of Cemex D was injected. Holes 2, 3, 4, 5 and 6 were drilled on the shaft perimeter. A total of 12,713 gallons of Cemex D was injected into holes 2, 3, 4, and 5. The exact quantity for hole 6 was not available, but 2,000 gallons is a reasonable estimate which would make an overall injection of over 17,500 gallons. The program was reasonably effective. The probe hole drilled near the shaft center was dry and during the time the BSB was in operation, only minor inflows of water were encountered.

2.7 Excavation and Construction of Shaft Collar

Excavation of the collar began in June, 1978. The first seven feet were removed with a backhoe. Then a clamshell, aided with airspades to maintain vertical walls and penetrate hard spots, sank the shaft to bedrock. The collar was completed to its planned depth of 47 feet by conventional drilling and blasting. The broken material was removed with the clamshell. Blasting mats were used to contain fly rock.

The 47-foot depth was necessary to ensure that the BSB grippers would bear on concrete backed up by rock, rather than unconsolidated materials.

The first seven feet of the collar was square, 26 feet by 26 feet inside dimensions with a 2-foot thick wall. The collar was then excavated at 26-1/2 feet rough diameter until a depth of 47-1/2 feet was reached. The lower section was lined with 9 inches of concrete. Thirty-eight yards of gravel were placed in the shaft bottom and contoured to match the cutterhead profile.

HISTORICAL WEATHER AVERAGES

TEMPERATURES EXTREMES AND AVERAGES FOR EACH MONTH

<u>MONTH</u>	<u>AVERAGES</u>		<u>EXTREMES</u>	
	<u>HIGH</u>	<u>LOW</u>	<u>HIGH</u>	<u>LOW</u>
January	54.3	34.1	81	-4
February	57.7	36.1	83	3
March	64.8	41.8	87	11
April	75.3	51.0	90	26
May	82.5	58.4	99	35
June	88.4	66.4	102	42
July	90.3	69.5	106	51
August	89.7	68.7	103	51
September	84.7	63.0	100	37
October	75.8	50.8	94	27
November	64.0	40.1	84	5
December	55.5	34.9	80	1

RAINFALL, AVERAGE AND EXTREMES FOR EACH MONTH (INCHES)

<u>MONTH</u>	<u>NORMAL</u>	<u>MAXIMUM</u>	<u>MINIMUM</u>
January	4.84	11.00	1.49
February	5.28	17.67	1.20
March	6.17	15.88	1.79
April	4.62	13.75	1.35
May	3.62	11.10	1.15
June	4.0	8.44	0.67
July	5.22	13.70	1.11
August	4.31	10.85	0.82
September	3.64	10.43	less than .01 inch (not measurable)
October	2.58	7.52	0.11
November	3.72	15.25	0.42
December	<u>5.23</u>	13.98	1.29
	53.23		

TABLE 3

TEMPERATURES EXTREMES AND AVERAGES

<u>MONTH & YEAR</u>		<u>AVERAGES</u>			<u>EXTREMES</u>	
		<u>HIGH</u>	<u>LOW</u>	<u>MEAN</u>	<u>HIGH</u>	<u>LOW</u>
November	1978	64.0	40.1	52.1	81	35
December	1978	55.5	55.5	45.2	79	20
January	1979	54.3	34.1	44.2	66	12
February	1979	57.7	36.1	46.9	76	14
March	1979	64.8	41.8	53.3	81	27
April	1979	75.3	51.0	63.2	84	37
May	1979	82.5	58.4	70.5	87	41
June	1979	88.4	66.4	77.4	93	42
July	1979	90.3	69.5	79.9	99	57
August	1979	89.7	68.7	68.7	94	56
September	1979	84.7	63.0	73.9	90	55
October	1979	75.8	50.8	63.3	86	39
November	1979	64.0	40.1	52.1	77	20
December	1979	55.5	34.9	45.2	72	19
January	1980	53.1	37.3	45.2	68	22
February	1980	53.6	31.0	42.3	82	15
March	1980	62.3	40.9	51.6	80	11
April	1980	73.8	47.9	60.9	89	37
May	1980	80.2	59.7	70.0	89	43
June	1980	88.3	66.7	77.5	94	51
July	1980	95.9	72.9	84.4	106	66

TABLE 4

MONTHLY PRECIPITATION

<u>MONTH</u>		<u>INCHES</u>	<u>DEVIATION FROM AVERAGE, Inches</u>	
November	1978	2.71	-1.01	
December	1978	5.43	+0.2	
January	1979	5.94	+1.1	
February	1979	4.82	-0.46	
March	1979	5.70	-0.47	
April	1979	13.75	+9.13	New Record
May	1979	6.64	+3.02	
June	1979	1.19	-2.81	
July	1979	9.87	-4.65	
August	1979	2.30	-2.01	
September	1979	10.39	+6.75	
October	1979	2.05	-0.53	
November	1979	5.51	+1.79	
December	1979	1.55	-3.68	
January	1980	6.66	+1.82	New Record
February	1980	2.36	-2.92	New Record
March	1980	15.88	+9.71	New Record
April	1980	9.10	+4.48	New Record
May	1980	7.30	+3.68	New Record
June	1980	3.04	-0.96	
July	1980	2.11	-3.11	

TABLE 5

G E O L O G I C A L D A T A

Depth		Classification	Hardness	
From	to			
.0	14.0	Overburden	S	
14.0	19.1	Shale	MH	
19.1	21.5	Silty Sandstone	MH	
21.5	24.0	Shale	MH	
24.0	38.0	Sandstone	H	
38.0	39.0	Shale - Few Coal Streaks	MS	
39.0	40.0	Clayey Siltstone	MS	
40.0	43.0	Sandy Siltstone	MH	H
43.0	64.4	Sandstone	H	
64.4	89.0	Sandy to Shaley Siltstone	MH	H
89.0	169.1	Silty Sandstone	MH	H
169.1	188.8	Sandstone	H	
188.8	191.0	Sandstone & Shale	MH	H
191.0	193.0	Shale	MS	
193.0	194.6	Carbonaceous Shale & Coal	MS	
194.6	195.7	Coal	S	H
195.7	210.6	Sandy to Shaley Siltstone	MH	H
210.6	213.0	Clayey Siltstone	MS	MH
213.0	216.5	Silty Sandstone	MH	H
216.5	238.0	Sandstone	H	
238.0	240.2	Shale	MH	
240.2	246.0	Sandstone	H	
246.0	253.0	Sandstone with Minor Shale	MH	H
253.0	285.0	Sandstone and Shaley Siltstone	MH	H
285.0	325.3	Sandstone	H	
325.3	330.5	Sandy to Shaley Siltstone	MH	H

TABLE 6

Depth		Classification	Hardness	
From	to			
330.5	345.0	Silty SS w/Sandy-Shaley Silts	MH	H
345.0	373.0	SS Interbedded w/SH Siltstone	MH	H
373.0	394.6	Sandy to Shaley Siltstone	MH	H
394.6	418.3	Sandstone	H	
418.3	488.0	Silty Sandstone & Sandstone	H	
488.0	504.6	Silty Shale	MH	
504.6	512.0	Sandstone and Shaley Siltstone	H	
512.0	513.0	Carbonaceous Silty Shale	MH	
513.0	516.0	Coal - Pratt Seam	S	
516.0	524.5	Shale	MH	
524.5	524.6	Coal	S	
524.6	554.7	Sandstone	H	
554.7	556.5	Coal	S	
556.5	557.0	Shale	MS	
557.0	583.0	Shaley Sandstone	MH	
583.0	583.5	Coal	S	
583.5	593.5	Clayey Siltstone	MS	MH
593.5	619.0	Sandstone	H	
619.0	619.5	Coal	S	
619.5	621.5	Clayey Siltstone	MS	MH
621.5	630.5	Sandstone & Shaley Siltstone	MH	H
630.5	632.6	Coal	S	
632.6	634.0	Shale	MS	
634.0	635.3	Coal	S	
635.3	643.0	Shaley Siltstone	MH	
643.0	644.1	Shale	MS	
644.1	645.3	Coal	S	
645.3	647.0	Shale & Shaley Coal	S	MS
647.0	672.5	Sandstone	H	

TABLE 6 (Cont)

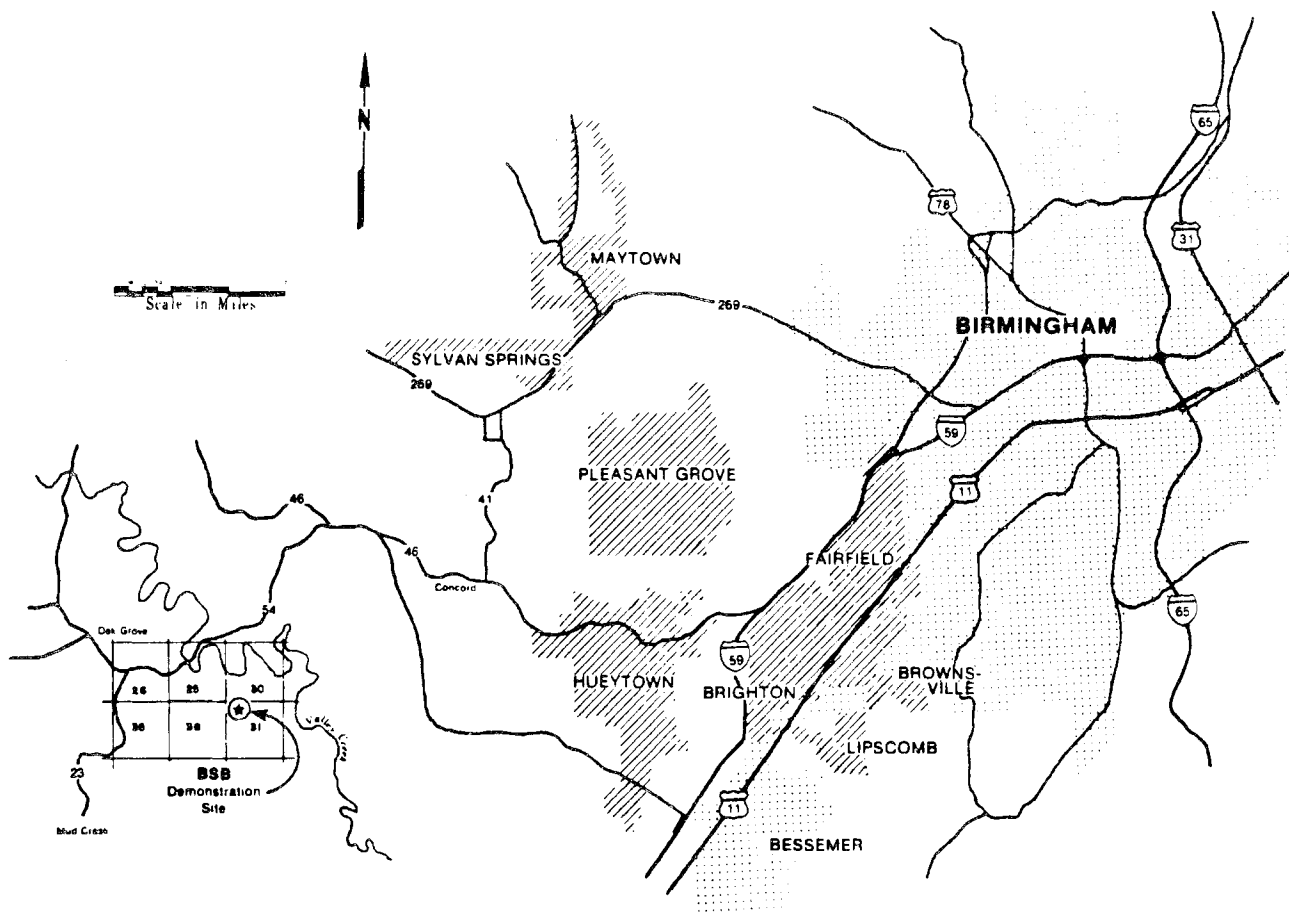
Depth		Classification	Hardness	
From	to			
672.5	677.5	Sandy to Shaley Siltstone	MH	H
677.5	683.0	Sandy Siltstone	MH	
683.0	689.2	Silty Shale	MS	
689.2	700.5	Sandstone w/Shaley Siltstone	MH	
700.5	712.0	Shaley Siltstone	MH	
712.0	712.5	Coal	S	
712.5	717.5	Clayey Siltstone	MS	
717.5	738.5	Sandstone & Sandy Siltstone	MH	H
738.5	746.0	Shaley Stilstone	MH	
746.0	747.0	Coal	S	
747.0	748.6	Sandstone - Coaly Matrix	H	
748.6	772.1	Sandstone	H	
772.1	775.4	Silty Shale	MH	
775.4	779.0	Sandstone - Shaley Streaks	H	
779.0	782.7	Silty Shale	MH	
782.7	836.6	Sandstone	H	
836.6	843.0	Shaley Siltstone Some SS	MH	
843.0	847.0	Silty Shale, Siderite Bandin	MH	MH
847.0	866.0	Sandstone & Shaley Siltstone	MH	H
866.0	873.0	Shaley Siltstone	MH	H
873.0	950.0	Sandstone & Siltstone	MH	H
950.0	976.6	Sandy to Shaley Slt & SS	MH	H
976.6	985.0	Sandstone & Siltstone	H	
985.0	996.0	Sandy to Shaley Siltstone	MH	H
996.0	1016.0	Shaley Siltstone	MH	
1016.0	1033.0	Shaley Slt to Silty SH	MS	MH
1033.0	1039.0	Shale	MS	
1039.0	1046.6	SS w/Shaley Siltstone	MH	H
1046.6	1050.0	Sandy Siltstone	MH	

TABLE 6 (Cont)

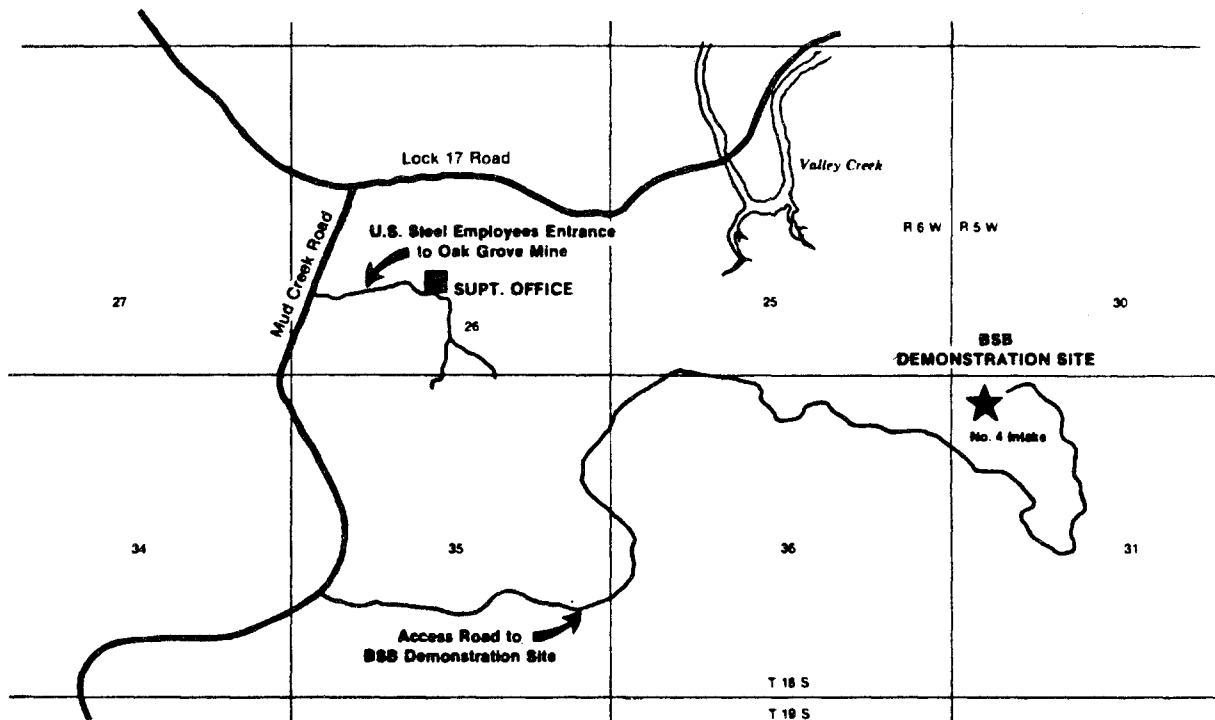
Depth		Classification	Hardness	
From	to			
1050.0	1059.0	Sandstone	MH	H
1059.0	1060.0	Sandy Siltstone	MS	
1060.0	1062.5	Shale & Thin Coal Seams	MS	
1062.5	1069.7	SS w/Siltstone Streaks	H	
1069.7	1073.4	Carbonaceous Shale & Coal	S	MS
1073.4	1078.2	Shaley Siltstone	MS	MH
1078.2	1081.0	Sandy Siltstone	MH	
1081.0	1123.0	SS w/Siltstone Streaks	H	
1123.0	1124.7	Coal - Mary Lee Seam	S	
1124.7	1129.2	Silty SH to Shaley Silt	MS	MH
1129.2	1133.4	Coal - Blue Creek Seam	S	
1133.4	1136.0	Siltstone	MH	
1136.0	1141.0	SS & Shaley Siltstone	MH	H
1141.0	1148.0	Shale & Shaley Siltstone	MS	MH
1148.0	1150.2	Coal - Jagger Seam	S	
1150.2	1163.0	Sandy Siltstone	MH	

H = Hard
 S = Soft
 M = Medium

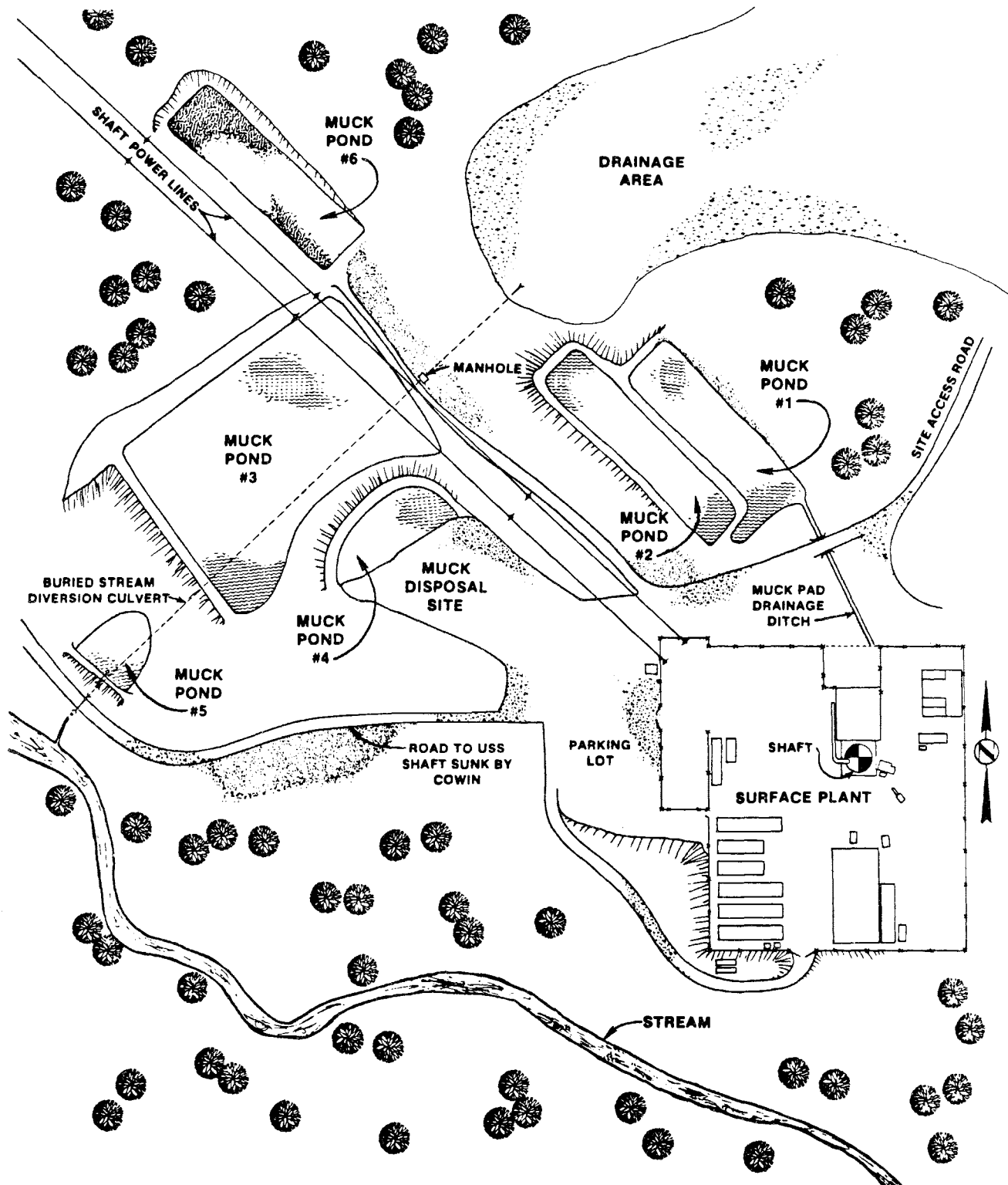
TABLE 6 (Cont)



SITE LOCATION MAP
Figure 3



**SITE IN RELATION
TO OAK GROVE MINE
Figure 4**



GENERAL WORK SITE MAP
Figure 5

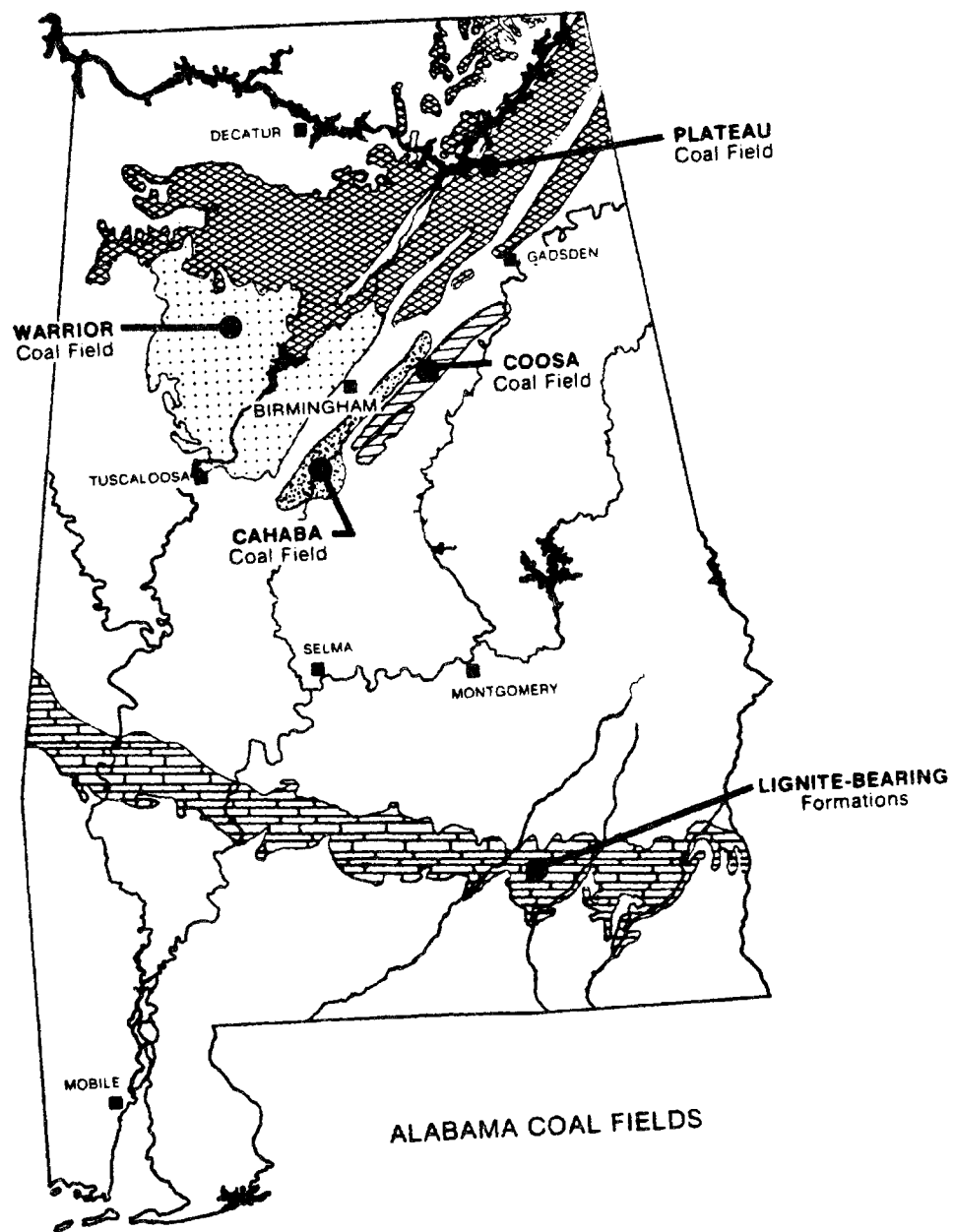


Figure 6

SECTION 3

MOBILIZATION

3.1 Gathering of BSB and Support Components at Field Trial Site

The U. S. Steel/Robbins contract was signed by U. S. Steel March 3, 1978. Robbins submitted copies of this contract plus the Robbins/Battelle and Robbins/Cementation contracts to the Department of Energy Contract Office on March 13. These actions signaled the initiation of onsite activities for the BSB project.

U. S. Steel scheduled the upgrading of the site access road and began work on obtaining the building permits (one for each building), electric, plumbing and septic tank permits, as well as a zoning variance for the office trailers.

Site activity work began April 10, 1978. By May 5, the shop buildings had been installed, one office trailer and dry trailer located on the site, and the telephone and power lines run to the site.

The first shipment of galloway components arrived on the site May 30.

The building foundations were completed, office trailers located, power hooked up and phones installed by the middle of June.

The 1,000 hp skip hoist motor arrived July 7, followed by the skip hoist on July 18.

The installation of the hoist house began July 20, and was essentially complete by August 2.

The first shipment of BSB components, cutterhead and cutterhead outriggers arrived on site August 8. The last main shipment, cutterhead support, arrived on site September 1, 1978. Since the collar was not complete, the BSB was partially assembled with the plan for these subassemblies to be lowered into the completed collar for final BSB assembly.

Measurement of the shaft collar upon its completion indicated it was out-of-round and clearances appeared to be inadequate to ensure successful installation. Subsequently, the BSB installation plans were again revised and the subassemblies were partially disassembled.

The BSB and its support components originated from several sources. The major components, supplier and point of origin are listed on Table 7.

3.2 BSB Project Personnel

The BSB project team was outlined earlier on a company basis. The personnel that each company used on the project changed during the life of the project. Table 8 is not a complete list, but it does cover most of the key site people during the field trial.

3.3 Erection of Surface Plant

The erection of the surface plant began in April, 1978. The front end loader arrived on site in late April. The concrete pads for compressor and maintenance shops were poured and the buildings set in place. The dry trailer and first office trailer were on site and set up by the middle of May. The hoist foundations were excavated and 280 cubic yards of

concrete were poured May 19. Power and six phone lines were installed by early May. By the middle of June, all office trailers were on site, blocked, and tied down. The back leg foundations for the headframe, the perimeter fence and the raw water supply were completed in June. The installation of the hoists started in June and continued through October, with the hoist house being assembled as time permitted.

The USBM instrumentation van arrived at the end of October and was hooked up so instrument checkout could proceed concurrently with BSB checkout.

The ventilation fan pads were poured in late October in preparation for using the fans while assembling the BSB in the shaft.

The roping of the winches began in November and continued into December.

The emergency hoist was installed in mid-November while the BSB was being assembled in the collar.

The general layout of the surface plant is shown on Figure 7. The hoist house foundation and hoist layout are shown on Figure 8. The headframe, sheaves and ropes are shown on Figure 9.

3.4 Blind Shaft Borer Assembly

The assembly of the BSB was initiated on the surface adjacent to the shaft. This was done because the collar was not yet completed because of delays involving shaft sinking plan approval.

3.5 Collar Clearance and Component Sequence Problems

When the collar was completed and measurements made, two problems were discovered. The concrete bore was out-of-round, creating a possible clearance problem, and the stabilizer shoes, when fully retracted, protruded 3/4-inch outside the lower shield.

The cutterhead support and cutterhead subassembly were dismantled and reassembled in the collar. The lower section of the inner tower was installed and installation of the front shield began. During installation of the front shield, a sequencing problem was discovered in that a plain shield segment, rather than a shield segment with stabilizer, had to be inserted last. This problem arose because it was the first time the BSB had been assembled in a confined space.

The stabilizer and torque cylinders were installed, and the transfer deck support was lowered.

The hydraulic power units, lubrication tank assembly and motor control center were lowered and installed. The drive motor assemblies were completed and installed.

The rear shield assembly was lowered in one lift using two hydraulic cranes with a combined rating of 210 tons.

The transfer deck, skip guide tubes, inner and outer towers and upper decks with hoppers were lowered and installed as an assembly. The air and hydraulic swivel assembly was installed.

At that time, only miscellaneous items necessary for hooking up the hydraulics, electrics and instrumentation remained to be installed.

The assembly of the BSB was completed November 7 and checkout of the machine started. The checkout of BSB functions was completed on the 14th and MSHA inspected the machine on the 15th and 16th.

MSHA inspectors found several minor discrepancies that were immediately rectified, allowing MSHA to give verbal approval on boring the shaft to the 100-foot depth.

A week was required to debug the hydraulic system, and boring was first attempted on November 27, 1978.

In attempting to "bore" through the pea gravel pad in the shaft bottom, many problems were encountered with the muck handling system. The most visible was the jamming of the flight conveyors. The leakage from the bottom of the muck measuring hoppers and the leakage from the bottom dump skips did not directly reduce penetration rates but indirectly influenced penetration by causing poorer working conditions and increasing the time required for keeping the BSB clean. A minor steering problem was encountered with the stabilizer shoe hydraulic system in that stabilizer pressure built up as the BSB was propelled.

Test personnel made several modifications to the flight conveyors as the BSB slowly bored down to the 100-foot depth. A design program was initiated to eliminate deficiencies and prepare new flight conveyors for installation when the BSB was shut down for installation of the galloway and erection of the head frame.

3.6 Initial Boring Using a Crane

The initial boring from 47 feet to 100 feet was done utilizing a crane to hoist a single skip from the BSB. The crane was

equipped with interlocks to prevent sideways movement while the crane was lowering or raising the skip within the confines of the skip tube. The BSB encountered immediate problems with the muck handling system which were not easily handled. These problems are discussed in detail in the problem book. The main obstacle was that the flight conveyors would not move the volume of material indicated by testing in Seattle.

3.7 Installation of Surface Support Components

The BSB reached a depth of 108.5 feet on February 5, 1979, at which time it was shut down for installation of its support equipment. The transformer was installed on the galloway and the galloway was then suspended from brackets in the collar. The sub-collar steel, collar steel and north section of the headframe were installed. The headframe raker legs and sheave decks were added, after which the headframe was plumbed and the legs grouted.

The manhoist rope was run over its sheave and socketed. The galloway suspension ropes were strung and the temporary galloway support removed. The mancage was suspended, providing a better means of access to the BSB. The transformer was hooked up electrically and also connected into the ventilation pipes per the MSHA variance.

The skip guide ropes were run over their sheave wheels, socketed and anchored. The Lake Shore hoist was roped up and the muck skips hung and positioned properly.

Preparations were made to resume boring in the planned cyclic operation. The emergency hoist installation was completed and boring efforts resumed on March 22, 1979. The installation of support equipment and modifications to the BSB took about seven weeks.

<u>Component</u>	<u>Original Supplier</u>	<u>Truck Loads</u>	<u>Point of Origin</u>
BSB	The Robbins Co.	(16)	Seattle, Washington
Parts Trailers (2)	The Robbins Co.	(2)	Seattle, Washington
Skips, Shearer, Scrolls	Lakeshore	(2)	Iron Mountain, Mich.
Skip Hoist	Lakeshore	(3)	Iron Mountain, Mich.
Headframe	Lakeshore	(3)	Iron Mountain, Mich.
Instrumentation Van	U.S. Bureau of Mines		Spokane, Washington
Galloway	Cementation	(2)	Tucson, Arizona
Galloway Winches	New Era	(2)	Canada
Man Hoist	Ottumwa	(1)	Tucson, Arizona
Emergency Hoist	Navy Winch	(1/4)	Tucson, Arizona
Air Compressors	Holman	(1)	Mascot, Tennessee
Water Truck (Potable)	International		Birmingham, Alabama
Boom Truck	Heilon International		Birmingham, Alabama
Dump Truck	International		Birmingham, Alabama
Front End Loader	Caterpillar	(1)	Tucson, Arizona
Hoist House		(1)	Birmingham, Alabama
DOE Office Trailer	Williams	(1)	Atlanta, Georgia
Office Trailer(s)	Rent-A-John	(4)	Birmingham, Alabama
Ventilation Fans	Cementation	(1/4)	
Auxiliary Power Generator	Empco Rental	(1/2)	Steubenville, Ohio
Concrete Forms	Ewing Record	(1)	Converse, Texas
Shop Buildings	Cementation	(2)	Mascot Nashville, TN
Transformers		(1/2)	
Hoist Ropes		(2)	Birmingham, Alabama
Electrical Cables		(1)	
Dry Trailer	Rent-A-John	(1)	Birmingham, Alabama
Service Lines		(2)	

BLIND SHAFT BORER AND SUPPORT COMPONENTS

TABLE 7

<u>Component</u>	<u>Original Supplier</u>	<u>(T.L.)</u>	<u>Point of Origin</u>
Miscellaneous	Cementation	(2)	
tugger hoist, power			
cable hoist, lighting			
cable hoist, signal			
card hoist, mancage,			
site fencing, site			
utilities, guard			
house			
Fan Line	Naylor	(5)	Birmingham, Alabama

BLIND SHAFT BORER AND SUPPORT COMPONENTS

TABLE 7 (Cont)

The Robbins Company

Jim Friant	- 1st Program Manager	- Seattle & Site
Jim Boyce	- Contract Administrator 2nd Program Manager	- Seattle & Site
Bob Moffat	- Engineer	- Seattle & Site
Jim Kindsvater	- Hydraulic Engineer	- Seattle & Site
Toby Elofson	- Field Service Technician	- Site
Ed Santorsola	- Field Service Technician	- Site

Cementation Company of America

I. S. Clelland	- 1st Project Manager
P. Gillette	- 2nd Project Manager
D. McLean	- 3rd Project Manager
F. Gillespie	- 4th Project Manager
C. Hereford	- 1st Project Superintendent
F. Aubuchon	- Mechanical Superintendent, 2nd Project Superintendent
J. Barton	- Electrical Superintendent
D. Pridemore	- Site Engineer
B. Marshall	- 2nd Mechanical Superintendent
T. Mann	- Shift Boss
D. Heit	- Shift Boss
R. Stupnikoff	- Shift Boss

Battelle - Pacific Northwest Laboratories

D. E. Rasmussen	- Engineering Associate	- Spokane & Site

PROJECT PERSONNEL

TABLE 8

C. Conrad	-	1st Engineering Technician	- Richmond & Site
K. Ames	-	2nd Engineer	- Richland & Site

Instrument Service Company Incorporated

J. Herron	-	Electronics Technician	- Site

Bureau of Mines

Paul Sands	-		- Spokane & Site

Department of Energy

Tim Zeigler	-		- Carbondale, Ill.
Gary Jurnberg	-	Technical Project Manager	- Carbondale, Ill.

Williams Brothers Engineering Company

Ray Amstutz	-	Project Manager	- Tulsa & Site
Tom Danowski	-	Project Engineer	- Site
Bob Morse	-	Field Engineer	- Site & Seattle

PROJECT PERSONNEL

TABLE 8 (Cont)

4 Winch Ropes

Type:	New Era Tool & Die, Western Ontario		
Max Load:	50,000 lb		
Drum Capacity:	5,000 ft		
Drum Diameter:	4'-10"		
Drum Length:	N.A.		
Rope Diameter:	1-1/8"		
Speed:	Min: 6.5	Max: 19	
Motor Horsepower:	30	Power 3/60/460	

Man cage

Type:	Ottumwa		
Max Load:	N.A. lbs		
Drum Capacity:	N.A. ft		
Drum Diameter:	60"		
Drum Length:	48"		
Rope Diameter:	7/8"		
Speed:	Min: N.A.	Max: 480	
Motor Horsepower:	165	Power 3/60/460	

Skip Hoist

Type:	Lake Shore, Double Drum		
Max Load:	22,680 lb		
Drum Diameter:	7'-5"		
Drum Length:	4'-6"		
Rope Diameter:	1-1/8"		
Speed:	Min: 100	Max: 1500	
Motor Horsepower:	1000	Power 3/60/4160	

HOIST INFORMATION

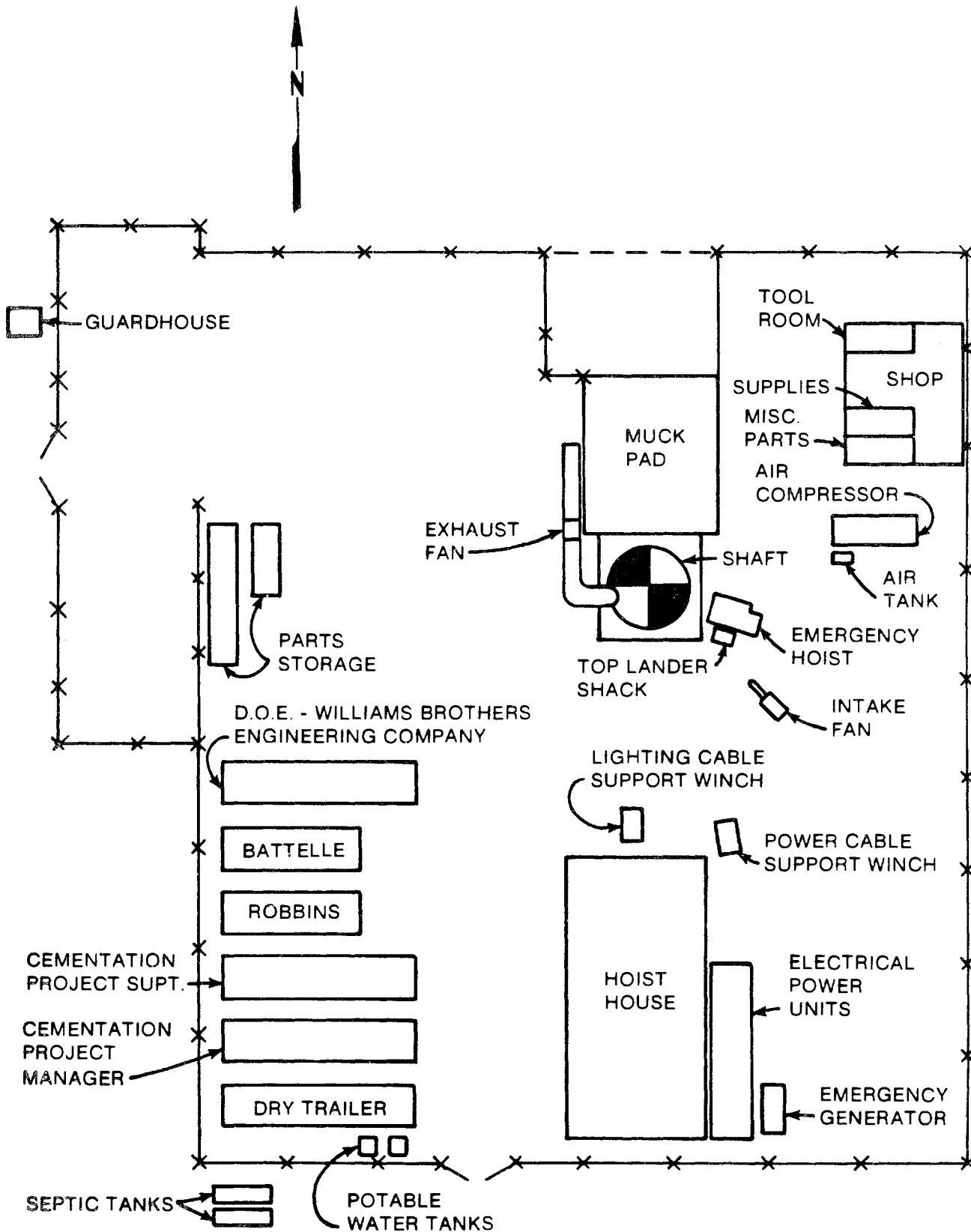
TABLE 9

Emergency Hoist

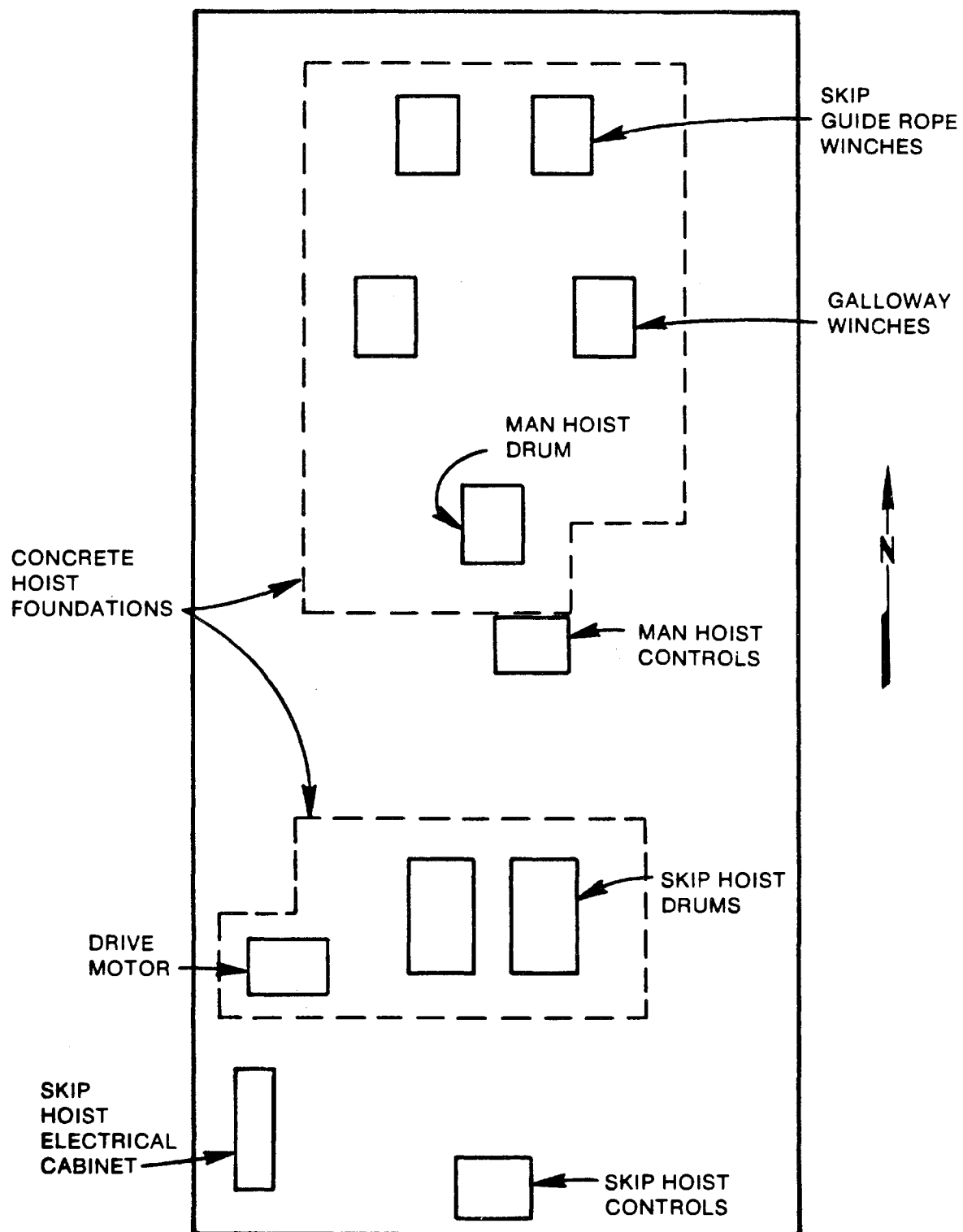
Type:	Navy Winch Spec. No. 6135
Drum Diameter:	20" (8" flange)
Drum Width:	19"
Rope Speed:	48 or 216 fpm
Rope Length:	1200'
Motor Horsepower:	22 Hp wound rotor Power 3/60/460

HOIST INFORMATION

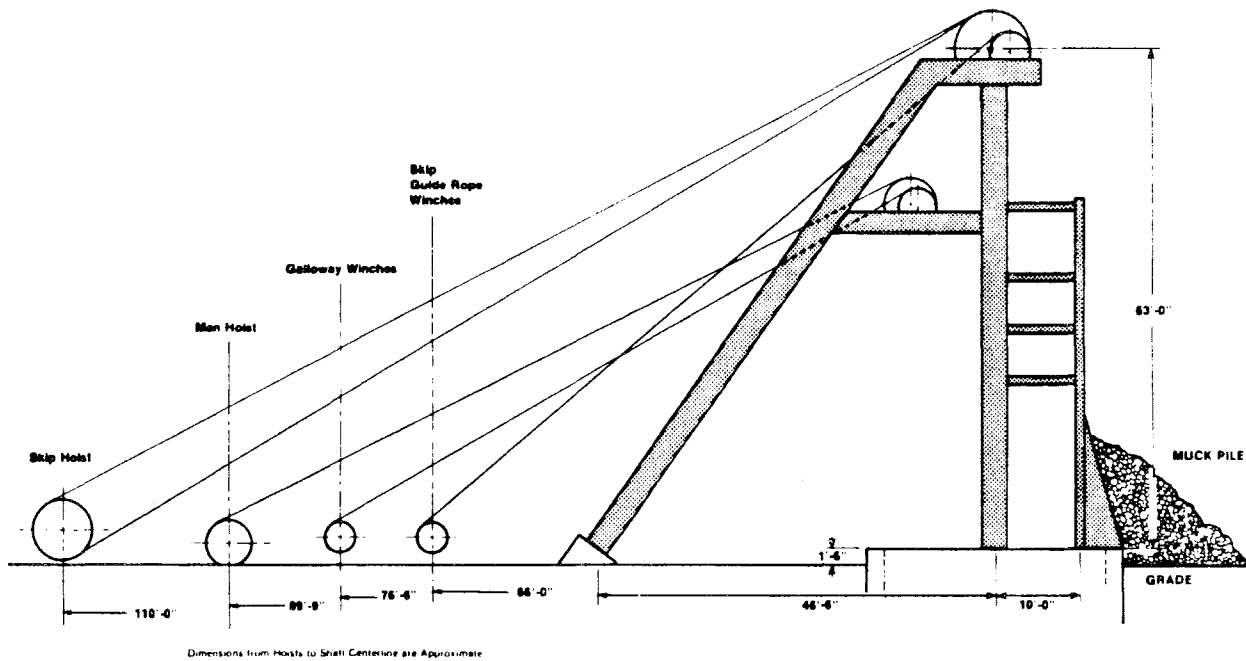
TABLE 9 (Cont)



SURFACE PLANT LAYOUT
Figure 7



HOIST HOUSE LAYOUT
Figure 8



HEADFRAME AND HOIST ROPES
Figure 9

SECTION 4

SHAFT ADVANCE

4.1 Communications Procedures

The overall organization of the BSB project resulted in several ambiguities in the distribution of project management responsibilities. The Robbins Company management in Seattle, Washington, Cementation management in Tucson, Arizona, and the on-site Cementation manager all were involved in day-to-day operational decisions. The distances, differences in time zones and difficulties in communicating a given problem tended to reduce upper management's awareness of the serious nature of many of the BSB problems. Thus, many problems were slow to be addressed and sometimes not properly understood by those making the decisions.

4.2 Start-Up Problems

The start-up problems were manyfold but primarily involved the mucking system and the hydraulic system.

The entire muck system, scrapers, flight conveyors, bucket elevators, distribution carousel, muck hoppers, hopper doors, muck skips, skip doors and skip control (primarily sequencing) exhibited problems early on. The problems resulted from either underdesign, misdesign because muck conditions were different from those anticipated, or misdesign because the test fixture was not 100 percent representative of the BSB in operational characteristics.

The hydraulic system was significantly different from the system on a tunnel borer and excessively complex. In addition to the tunnel borers' cylinders (propel, gripper, torque, and steering-side support) there were flight conveyor motors (2), bucket elevator motors (2), and a hydraulic driven lubrication system, all of which greatly increased the volume of hydraulic fluid in use. The high flow volume problems were compounded by the use of fire-resistant fluid.

4.3 Summary of Major Operational Problems

The problems during startup were not completely eliminated. Some of the minor troubles, such as misconnected hoses, were resolved. The problems with the mechanical muck system continued throughout the project. The retrofit flight conveyors were of marginal benefit over the on-site modifications to the originals. The bucket elevator power problems increased significantly as the fixed center scrapers wore and allowed muck to build up on the face.

The skip hoisting system required modifications to minimize leakage of wet muck and continually exhibited sequencing problems. The hydraulic problems were intensified for a period because of addition of an incompatible fluid to the system. They also were intensified as pressures were raised in efforts to improve performance. The lubrication system suffered from contamination and subsequent wear problems.

The permissible electrics experienced corrosion problems as a result of the wet, dirty environment in which the BSB operated. The time required for concreting lining and advancing the services was approximately three times greater than the scheduled eight hours. The boring and lining problems necessitated operation in a cyclic, rather than continuous, fashion. Shaft advance cycles 2 and 3 were never attempted.

The laser guidance system had convergence and divergence problems below the 450-foot depth, resulting in the loss of considerable boring time. The muck disposal ponds were not initially designed with expectations of boring wet, so treatment and disposal of shaft water became a problem.

An in-depth review of problems actually encountered during the project and potential problems with recommended solutions is presented in "Project Problems."

4.4 Significant Events

During the course of a Research and Development Program, there are many events that prove to be significant when the completed project is reviewed. A few of the more important events are presented. A chronological listing of significant events, as taken from Williams Brothers Engineering Company daily reports, is presented in the "Project Log."

Nov. 16, 1978	Received MSHA permission to bore.
Dec. 3, 1978	Hoisted first skip of gravel.
Feb. 2, 1979	First day of boring more than 10 feet. (1.24 feet/hour of boring time)
Mar. 22, 1979	First boring with BSB support systems installed.
Apr. 21, 1979	Completed boring first 20-ft. cycle.
Jul. 18, 1979	Subcontractor began first cleaning of primary settling pond.
Jul. 27, 1979	Discovered that incompatible FR fluid had been added to the hydraulic system.
Oct. 31, 1979	Completed 70 feet of boring in one month.
Dec. 5, 1979	After one year of operation, penetration totaled 408 feet.

Apr. 29, 1980	Shaft reached 580 feet (1/2 the planned depth).
Apr. 30, 1980	Project shut down due to contamination of surface stream.
May 20, 1980	U. S. Steel was unable to accept new proposed boring schedule due to the late completion date. It was requested that boring activities cease June 30, 1980, and the shaft be completed conventionally per contractual agreement.
Jul. 3, 1980	U. S. Steel again stated that an additional extension of shaft completion date was impossible.
Jul. 7, 1980	It was determined that an additional 8 feet must be bored to allow removal of BSB rear shields.
Jul. 9, 1980	BSB completed the 8 feet and was shut down.
Jul. 11, 1980	Official word was given to Cementation to stop boring and demobilize BSB.
Aug. 26, 1980	Removed cutterhead to complete hoisting of BSB.
Aug. 28, 1980	Contract awarded to Cowin to complete shaft by conventional means.
Sep. 16, 1980	Headframe was removed for disassembly and stacking.
Oct. 10, 1980	Last day for hourly employees. All DOE equipment stored within fence awaiting storage preparations.

4.5 Implementation of Boring and Concrete Lining Cycles

The mining plan called for use of three different cycles for boring and concrete lining and service extension activities.

Cycle 1 was to be continued until the BSB System was debugged and working smoothly. The BSB was to shut down upon completion of boring 20 feet, the transformer de-energized, the galloway repositioned and service lines extended. When the service line extension was completed, the galloway would be lowered to its concreting position. Following a satisfactory methane check and one minute fresh air purge of the galloway mounted transformer, power could be re-established to the BSB. The concrete curb ring was to be attached to the galloway mounted winches, struck from the previous pour, and lowered 20 feet, where it would be supported on eleven 1-1/8 inch diameter hanging rods. The ring would be leveled and blocked into position using the laser beams for centering it in the shaft. This work was done from the transfer deck of the BSB after which the 20-foot concrete form was to be lowered and connected to the curb ring. The concreting dash pots and elephant trunks were then to be attached to the slicklines and distribution hoppers. The elephant trunks were then to be placed into the form pour doors and the concrete poured. Upon completion of the concrete pour and cleanup, the BSB would resume boring operations. During Cycle 1, the BSB utilization was to be 23 percent, allowing 20 feet of advance each 24 hours. Eight hours were allocated to the extension of services and lining, with 16 hours for boring twenty feet.

Cycle 2 was the same as Cycle 1, up to the start of the concrete pour. Under Cycle 2 plans, the BSB was to resume boring simultaneously with the placement of concrete. During Cycle 2 operations, the overall BSB utilization was to increase to 46 percent, allowing 40 feet of advance each 24 hours. Six hours were allocated to each extension of services and lining, with eight hours to boring each twenty feet. The boring would be resumed earlier, causing a two-hour overlap in activities.

Cycle 3 was the theoretical limit of BSB operation. The extension of services and concreting time were to be reduced to four hours and boring time reduced to seven hours, again with a two-hour overlap. The overall utilization was to increase to 62.5 percent, allowing completion of 60 feet of shaft every 24 hours.

All three cycle plans were based on the BSB being capable of removing muck at the rate of 45 cubic feet per minute.

In actual practice, the BSB did not handle muck well enough to permit long-term boring rates in excess of one foot per hour. High maintenance further increased the time necessary to bore 20 feet. The time for extension of services and concrete lining was greater than the actual boring time over the life of the project. For each cycle, the actual boring of the 20 feet was, in general, less than 12 percent of the total cycle time. Records indicate that 60 to 70 percent of each cycle time was attributed to some form of downtime. For the best 20-foot cycle, the BSB bored less than 19 percent of the time.

In practice, the BSB followed a Cycle 1 plan but never approached its time schedule. The best sustained effort was 22 feet bored and 20 feet lined in one week.

4.6 Monitoring, Storing and Evaluation of Data

The task of monitoring, storing and evaluation of BSB data was assigned to Battelle Northwest Laboratories. They were responsible for the machine low voltage electrics and worked with the U. S. Bureau of Mines on the data collection system. The Bureau provided the instrumentation plan and the equipment to store and display collected data.

It was decided that certain functions should be monitored to fully evaluate the BSB performance. The data to be collected and the required number of sensors are:

A.	Downhole Data	Sensors
1)	X & Y location of BSB from Shaft Center line	(2)
2)	Cutterhead Input Power	(1)
3)	Drive motor current (1 only)	(1)
4)	Clutch air pressure (cutterhead drive)	(1)
5)	Cutterhead penetration rate	(1)
6)	Cutterhead displacement	(1)
7)	Propel cylinder pressure, 1 for each bank	(3)
8)	Steering cylinder displacements	(3)
9)	Steering cylinder pressures	(3)
10)	Torque cylinder displacement	(1)
11)	Torque cylinder pressure	(1)
12)	Hydraulic oil high temperature on/off at 140°F	(1)
13)	Hydraulic oil level low on/off	(1)
14)	Flight conveyor rpm	(2)
15)	Flight conveyor pressures	(2)
16)	Bucket elevator rpm	(2)
17)	Bucket elevator pressures	(2)
18)	Clear water pump on/off	(1)
19)	Methane detectors	(2)
B.	Surface Data	
1)	Inlet airflow	(1)
2)	Exhaust airflow	(1)
3)	Shaft depth	(1)
4)	Ambient temperature	(1)
5)	Humidity	(1)
C.	Calculated Data	
1)	Total propel cylinder pressure	(1)
2)	Radius of error (BSB deviations from center line)	(1)

Transducers provided signals which were transmitted to a U. S. Bureau of Mines mobile instrumentation van which contained equipment to automatically gather and process the data. The van housed a Hewlett Packard 2100 mini-computer and its peripheral equipment.

The intrinsically safe instrumentation system and data acquisition equipment are fully described in a report, "Blind Shaft Borer Instrumentation," prepared by the U. S. Bureau of Mines (Spokane Mining Research) for the U. S. Department of Energy.

4.7 Comparison of Proposed and Actual Progress

The original schedule for shaft completion was considered to have sufficient time included to allow for R&D activities and correction of unexpected operational problems. Problems encountered with the muck handling system during the boring to the 108-foot depth resulted in the proposed completion date being extended. This second revision reflected the additional time for modifications and boring the remaining depth following a Cycle 1 boring and lining schedule at reduced rates. Each subsequent revision to the schedule and proposed completion date adjusted the anticipated penetration rate downward toward the actual penetration rate. Revision 5 was still optimistic by a factor of three, based on the January through June, 1980, BSB performance.

The BSB was scheduled to bore 20 feet per day. A penetration rate of 10 feet per day was achieved only infrequently. The deepest penetration for one week was 22 feet. The total boring time was to be 18 to 20 weeks, allowing for some delays; but after 16 months, the shaft had barely passed the halfway point.

Another optimistic portion of the original schedule showed that site demobilization was to be finished in eight weeks. However, five weeks were actually required to remove the BSB from the shaft, and an additional six weeks were required to further dismantle the BSB and demobilize the other site facilities. Additional time was required to clean the BSB and prepare it for shipping and storage, but this was not anticipated in the original schedule.

4.8 Shaft Ventilation

The ventilation of this shaft was more complex than most shaft sinking projects in that MSHA granted a variance allowing the use of a non-permissible transformer downhole. There were restrictions placed on the use of this transformer that affected both the ventilation plan and the overall use of the galloway.

The transformer was enclosed and connected to both the downcast ventilation line and the upcast exhaust line. The airflow through the transformer enclosure was targeted at 1,500 cfm at a positive pressure of two inches water gage, compared to the shaft with minimum values of 1,200 cfm and 0.1 inch water gage positive pressure.

The exhaust air upcast duct was targeted at 15,000 cfm, and upcast in the shaft was targeted at 10,000 cfm. The minimums were 12,000 cfm and 5,000 cfm respectively. The downcast fresh air duct was targeted at 25,000 cfm with a minimum of 17,000 cfm.

The exhaust system was carried to within six feet of the shaft bottom by use of the inner tower of the BSB. By doing this, at least 12,000 cfm was assured to sweep the face. This created problems in cold weather because work in the inner

tower was miserable and frequently the miners would shut off the exhaust fan in violation of MSHA regulations.

There were two continuous methane monitors on the BSB and one mounted on the galloway. These provided a warning at one percent and shut off electrical power at two percent. In addition, the BSB was provided with a network of tubes, and twice during each shift the fire boss checked various locations for methane using a portable methane meter.

The ventilation system was adequate, and no problems with methane or other gases were encountered. The ability of the system to handle large methane inflows was not tested, nor was the capability of the system tested at full shaft depth. The ventilation system capacity was excessive compared with most shaft sinking ventilation circuits, but this was necessary to ensure safety, considering the extensive use of electronics on the BSB. As a result, the major complaint about the system was that in cold weather it moved too much air and made working conditions miserable. In some downhole locations, the air velocity combined with low temperatures made conditions intolerable.

4.9 Disposal of Shaft Water and Muck

The BSB was intended to bore in a relatively dry mode, with the only sources of water being that used for dust suppression and the natural inflow to the shaft that pregrouting did not completely seal off.

The pregrout was good. Any unexpected but sizable flows encountered were to be further grouted to minimize water inflow. The volume of water to control dust was estimated to be 10 percent by weight, or about 60 gpm at an advance rate of 3.5 feet per hour. This is a considerable volume of water,

but it would have been combined with the muck and not present as free moisture.

The BSB failed to bore successfully in the dry mode for two major reasons. First, it was nearly impossible to switch from the wet mode (natural condition after any shutdown) to the dry mode without plugging the muck handling system. Secondly, when boring in the dry mode was successful, the generation of dust was excessive and working conditions both underground and on the surface were intolerable. The cutter-head dust suppression could not handle the dust generated because of the flat face scrapers and subsequent regrinding of the muck.

During the early stages of boring, it was noted that additional water actually helped the performance of the muck handling system. It appeared to let the muck flow and reduce the jamming and plugging due to sticky muck. The difficulties associated with boring dry or with moisture contents that produced sticky muck led to the decision that the BSB would bore primarily in the wet mode.

Sufficient water to overcome the adsorption of the high percentage of fines in the muck was required to bore in the wet mode. Subsequently, 20 to 30 gpm of water was added even when the borer was only penetrating at the rate of 1/2 foot per hour. The water quantity was not well regulated because the operator could not see the face or any of the muck handling system.

With the start of wet boring, it was soon realized that the original muck ponds were inadequate and an additional pond to provide a first stage settlement area for the fines was

constructed next to the original pond. A drainage ditch was constructed from the muck pad by the collar to the new pond to drain the excess contaminated water. The muck was removed by the front end loader to its disposal area. Most of the suspended fines settled from the contaminated water in the first pond, but a significant volume of extremely fine material stayed in suspension. The second settling pond continuously leaked contaminated water to the secondary stream, so a culvert was laid through the muck pond area in which the small stream was directed. The small dam at the lower end of the draw then served to catch the contaminated leakage water.

Only minor pollution problems were encountered until the first settling pond filled with fines and had to be cleaned. An additional pond was constructed to hold the fines that were clam shelled from the first pond. This new pond also collected rain water and soon it was noted that pollution of the stream was occurring again. U. S. Steel advised that the project should be shut down until the problem was solved. A bundle of three PVC pipes (2 @ 10" diameter and 1 @ 8" diameter) were snaked through the leaking culvert and grouted at each end. The small stream that had been going through the culvert was now directed through the PVC which was sealed against pollution. The grouting at the lower end prevented leakage into the steel culvert from reaching the stream.

To minimize the collection of rain runoff in the ponds, gravel-lined intercept ditches were constructed on both sides of the last pond. The dam on pond 3 was raised and extended until three sides were enclosed so only rainfall on the muck disposal site could flow into the pond.

A new pond was constructed to receive treated fines from the first stage settling pond. A mixture of 1 part hydrated lime

and 2 parts fly ash sufficiently thickened the slimes from the first settling pond so that they could be buried.

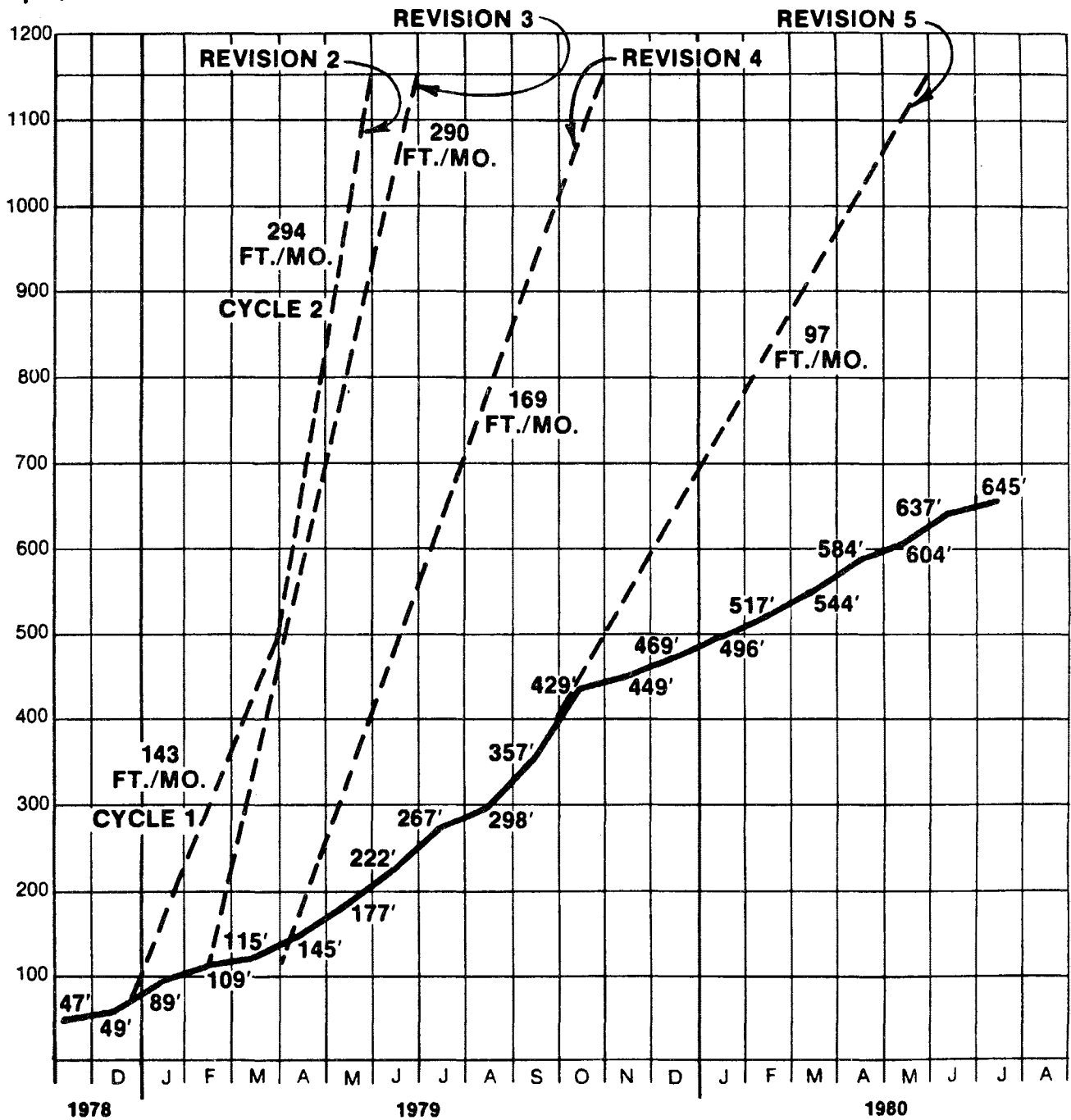
The contamination of the stream was not completely stopped, even though the lower dam was grouted and efforts were made to recycle the water.

It is now evident that the ponds should have been constructed differently. The ponds were constructed on ground immediately above fractured rock which subsequently allowed seepage to contaminate the stream. Had the high water usage been expected, means to recycle most of it to the shaft could have been provided. Subsequently, the ponds could have been smaller, lined with clay or plastic and less susceptible to overflowing as a result of heavy rainfall.

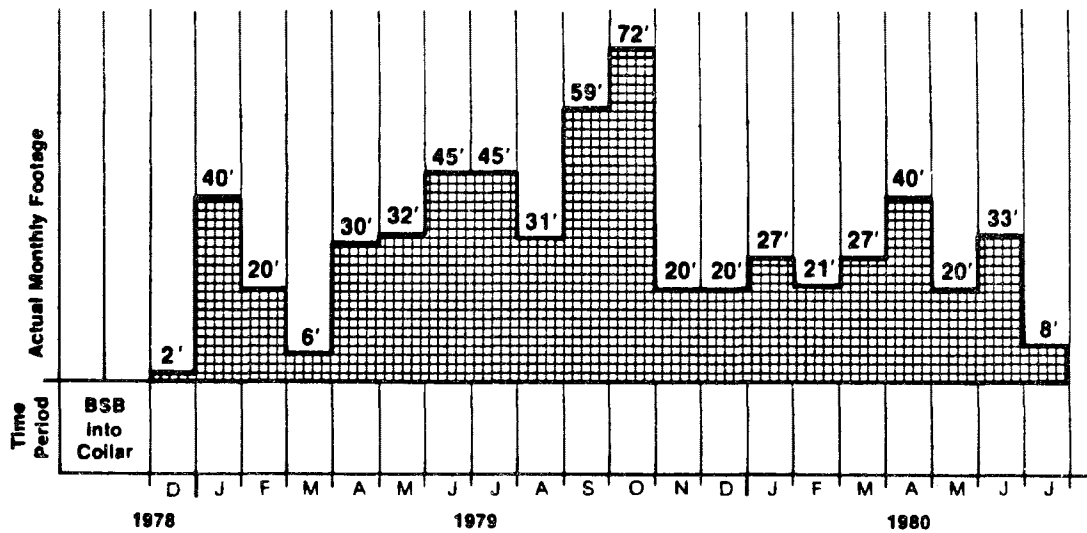
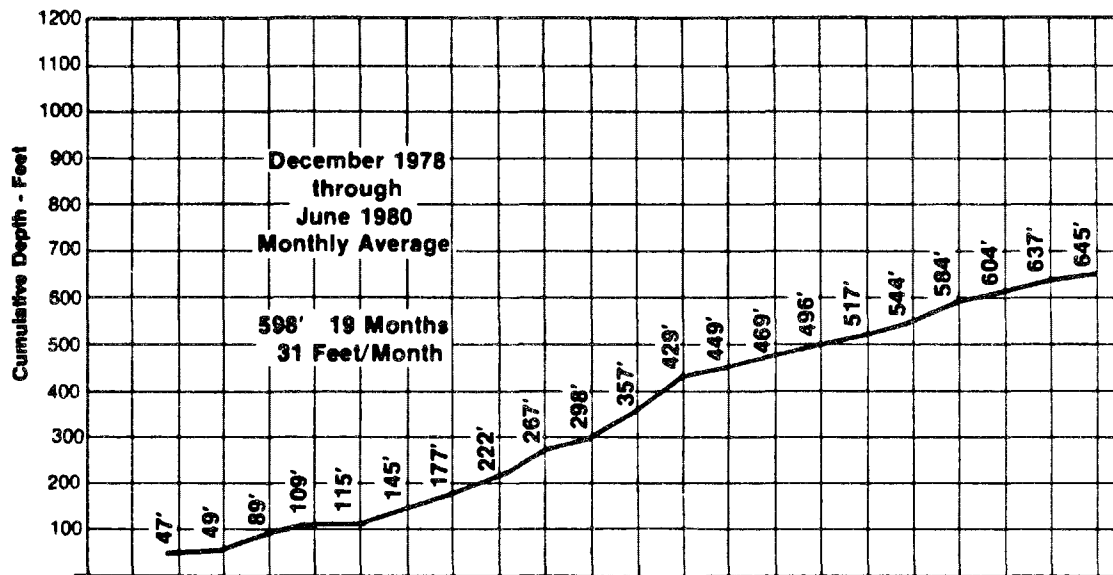
The result of not providing for boring wet was two shutdowns at the request of U. S. Steel to stop contamination of the stream. Also, the poor results in controlling the contamination may have adversely affected U. S. Steel's decision to refuse the last request for a time extension.

CONTRACTOR'S SCHEDULE REVISIONS

Depth, Feet



MONTHLY AND CUMULATIVE
FOOTAGE BORED
Figure 10



**PREDICTED AND ACTUAL
FOOTAGE BORED
Figure 11**

**BSB PROJECT, OAK GROVE, ALABAMA
WBEC PREDICTED COMPLETION DATES**

PERIOD		RECORDED FOOTAGE				PREDICTED BORING COMPLETION DATE							
MONTH	NO.	MONTH	CUMU- LATIVE	MONTHLY AVERAGE	REMAINING TO COMPLETE SHAFT	COMPLETION TIME = $\left(\frac{\text{REMAINING FOOTAGE}}{\text{LAST 'N' MONTH FOOTAGE}} \right) \times \text{N}$							
						CUMULATIVE FROM 4-79		(N = 3) LATEST 3 MONTHS			(N = 6) LATEST 6 MONTHS		
						NO. MO.	END OF MONTH DATE	AVG.	NO. MO.	END OF MONTH DATE	AVG.	NO. MO.	END OF MONTH DATE
Start	0	47	47	N.A.	1129								
Dec. '78	1	2	49	N.A.	1131								
Jan. '79	2	40	89	N.A.	1071								
Feb. '79	3	20	109	N.A.	1051								
Mar. '79	4	6	115	N.A.	1045								
Apr. '79	5	30	145	30	1015	34	Feb. '82						
May '79	6	32	177	31	983	32	Jan. '82						
Jun. '79	7	45	222	35	938	27	Sep. '81	35	27	Sep. '81			
Jul. '79	8	45	267	38	893	24	Jul. '81	40	23	Jun. '81			
Aug. '79	9	31	298	36	862	24	Aug. '81	40	22	Jun. '81			
Sep. '79	10	59	357	40	803	20	May '81	45	18	Mar. '81	40	20	May '81
Oct. '79	11	72	429	45	731	17	Mar. '81	54	14	Dec. '80	47	16	Feb. '81
Nov. '79	12	20	449	42	710	17	Apr. '81	51	14	Jan. '81	45	16	Mar. '81
Dec. '79	13	20	469	39	691	18	Jun. '81	37	19	Jul. '81	41	17	May '81
Jan. '80	14	27	496	38	664	18	Jul. '81	22	30	Jul. '82	38	18	Jul. '81
Feb. '80	15	21	517	35	643	19	Sep. '81	23	29	Jul. '82	36	18	Aug. '81
Mar. '80	16	27	544	33	616	19	Oct. '81	25	25	Apr. '82	31	20	Nov. '81
Apr. '80	17	40	584	36	576	16	Aug. '81	29	20	Dec. '81	26	22	Feb. '82
May '80	18	20	604	35	556	16	Sep. '81	29	19	Dec. '81	26	21	Feb. '82
Jun. '80	19	33	637	35	523	15	Sep. '81	31	17	Nov. '81	28	19	Jan. '82
Jul. '80	20	8	645	*	515		SHAFT TO BE COMPLETED CONVENTIONALLY						

*Average not updated as July boring was for demobilization purposes only.

N.A. - Not Applicable - All support systems not installed.

Figure 12

SECTION 5

DEMOBILIZATION

5.1 Termination of Boring

On May 20, 1980, U. S. Steel informed the contractor and the Technical Project Officer that the Oak Grove mining plan could not be revised to allow further extensions of the shaft completion date. Based on the latest BSB performance and realistic performance predictions of planned modifications, the contractor would need to stop boring June 30, 1980, and start demobilizing the BSB. Preparations were to be made for subsequent and expedient completion of the shaft by conventional excavation.

The remainder of the time was spent attempting to repower the mechanical muck system with the hope that the modification would substantially increase the performance of the BSB and could be used to negotiate a new completion date. On July 3, 1980, the Contractor and DOE attempted to get U. S. Steel to reverse their May 20 instructions with the condition that boring would cease after any month in which the BSB performance would not at least match that of an excavation shaft contractor. U. S. Steel would not agree and required that the BSB be demobilized immediately.

To begin disassembly, the BSB had to bore an additional 8 feet so that the rear shield could be lifted up and into the center of the shaft. Demobilization started July 11, 1980.

5.2 Modification of the Shaft Cover

The intent was to remove the galloway in two full diameter sections and the BSB in the largest assemblies that could be

hoisted up the shaft. Further disassembly for shipment would be on surface.

All the front (north) structure of the headframe containing the skip dumping scrolls were removed to expose the entire perimeter of the shaft. The shaft cover was then modified so that it would roll to one side to expose the entire diameter of the shaft to pass the full diameter galloway. The two skip doors on the north side were enlarged into one door (approximately one-half the size of the shaft cover) to be used for removing the BSB assemblies.

5.3 Removal of the Galloway

All power lines in the shaft, umbilical cables from the galloway to the BSB, skip guide ropes and skip and mancage hoist ropes were removed from the shaft and spooled on the hoist drums so that there was no communication between the galloway and BSB. The galloway was hoisted to surface with the mancage guide ropes in one shift and chaired just below the shaft cover.

With direct surface access to the galloway, the operator stripped all his owned equipment, disassembled the galloway into two sections, a top deck with transformer and two bottom decks. Both sections were removed from the shaft with a crane and stored on the north side of the shaft.

Communication with the BSB was established by lowering the mancage guide rope with concrete filled drum weights attached.

5.4 Removal of the Blind Shaft Borer

All the concrete forming equipment was removed from and stored northeast of the shaft.

Hydraulic hoses were removed, the connections leading to the permanent hydraulic components were capped and hoisted to the surface. All showed signs of abrasion and wear, and it was obvious that costs to preserve them would be in excess of their replacement cost. Disassembly and removal of the skip tubes, inner and outer towers, the decks, including the lowermost transfer (operator) deck, and a majority of the hydraulic cylinders was straightforward. The miners were able to remain in the shaft as the equipment was hoisted to the surface.

Since the miners had lost their overhead protection, they had to be hoisted to the surface when the drive motors, rear and front shield with grippers, cutterhead support and cutterhead were hoisted to the surface. The efficient two shifts deteriorated to one shift in which the miners spent a considerable amount of time waiting for the assemblies to be hoisted. All the assemblies were stored within the guarded fenced yard.

5.5 Removal of Shaft Service Lines

The elevated exhaust fan, together with the dust suppression ventilation lines were removed at the beginning of demobilization.

The excavation contractor required that only the 36-inch pressure ventilation, 2-inch water, and 4-inch air lines remain in the shaft for sinking. The remainder of the lines were removed using the modified top deck of the galloway. After all work was completed in the shaft, the pressure fan was removed.

5.6 Disassembly of Surface Plant

The headframe, hoist house and shaft cover were DOE property. The remainder was either rented from the operator, Cementation, or from local suppliers. The size of the fenced yard was increased, and all the DOE owned equipment was disassembled and stored within. The remainder was disassembled and almost immediately shipped to the owners' yards.

All settling ponds were treated with alum and the supernatant pumped into the main stream. Restoration of the site was subcontracted to a local contractor. Fill areas No. 4 and 6 (used to store the solids from No. 1 pond) were leveled, settling ponds No. 3 and 5 were filled and the entire site was contour graded. Ponds No. 1 and 2 were retained to handle the shaft water encountered during excavation.

All the wire rope and the major power lines were spooled on reels and prepared for extended storage. The worn mechanical muck handling system, scrap steel, worn cutter rings and used hoses were stored in separate piles awaiting disposition.

WBEC tagged the DOE owned major components so that, in the event all the personnel familiar with the equipment left the site and new personnel were brought in to complete the task, they would be able to identify the parts for the required labeling after processing and prior to shipment.

5.7 Preparation of BSB Components for Storage

The operator's contract was extended to supervise the preparation for storage. All the DOE owned equipment, except the headframe, wire rope, electric cables, hoist house and scrap, were disassembled and trucked to a subcontractor's yard in

Pinson Valley, about 50 miles from the site. The wire rope was sold, since it has no safe extended storage life; and the remainder, except scrap, was shipped directly to the designated DOE storage site in Mercury, Nevada.

At the subcontractor's yard in Pinson Valley,

- o Steel fabrications were steam cleaned, sandblasted and primed.
- o Hydraulic pumps and motors, controls and valving were tested and purged by a commercial hydraulic repair house, sealed in plastic bags with desiccant and boxed. Those pumps that did not meet specifications were identified on a list with an estimate of the parts required to repair them.
- o Hydraulic cylinders were purged, refilled with mineral based oil and sealed by the contractor's representative.
- o Main bearing was checked by the supplier's representative, then preserved and boxed per his recommendation.

All the parts were labeled with reference to the parts list for future ease of assembly. Everything, with the exception of the electric cables will have a storage life of a conservative 10 years.

5.8 Shipment of BSB Components to Storage Site

The DOE chose to ship the BSB and complimentary equipment to Mercury, Nevada, because the storage area is on highly secured government land and the dry climate will minimize deterioration of the equipment.

The headframe, which was initially primed and showed minimum signs of deterioration, was shipped with the hoist house, guard shack, fencing and electric cable to Mercury. The remaining scrap was shipped to the Pinson Valley yard so that none of the equipment used to bore the shaft was left on the site.

Everything except the scrap was shipped from the Pinson Valley yard to Mercury, Nevada. Per procurement's instructions, bids were taken and the scrap was to be sold to the highest bidder.

5.9 Discard of Expendables

During demobilization, it became apparent that such items as hydraulic, air and water hoses had no salvage value, since they had 2 years of severe service. These items were discarded.

The iron scrap pile consisted of worn out cutter rings, flight conveyor and bucket elevator components, scrapers, and scrap steel. Their value was, at best, the market price of scrap iron less the shipping cost.

Since the intent was to convert the muck pickup from a mechanical to vacuum systems, both the flight conveyor and bucket elevators which showed more than 25 percent wear were classified as scrap.

The shaft cover had been modified a considerable number of times and finally when removed was so badly cut up that it was classified as scrap.

SECTION 6

BSB DESIGN AND OPERATION COMMENTS

The failure of the BSB to complete the Oak Grove Ventilation Shaft can be related to design and operational problems that manifested themselves during the project. Comments on both the design and operation for 15 categories of the BSB are as follows:

6.1 Cutterhead

Several major problems were directly related to the cutterhead design which was influenced by the use of a mechanical muck pickup system.

The cutterhead was a full-face design with an extremely shallow "w" configuration. It required the use of scrapers to drag the muck across the face to form a furrow for pickup by the flight conveyors. Neither the replaceable scrapers nor the fixed inner scrapers completely cleaned the face. The replaceable scrapers frequently broke off, jamming the muck system. The fixed inner scrapers were severely worn and could not be replaced because of the cutterhead configuration and MSHA regulations. This was a major factor in deterioration of performance.

The full-face cutterhead required the use of back loading cutters, which in combination with the low profile and internal bracing of the cutterhead, made inspection and replacement of worn cutters time consuming. The difficulty in replacing cutters, coupled with high cutter wear, resulted in considerable BSB downtime. The regrind of the muck left by the scrapers shortened the cutter life when boring wet and caused dust, considerable heat and bearing failures when boring dry.

The scraper wear problems did not exist during the Seattle tests of the vacuum pickup system. As soon as the scraper adjusted its clearances to the rotating concrete bowl, only muck passing between the bowl and scraper caused scraper wear. On the BSB, the profile of the face was continuously changing, resulting in the scrapers frequently contacting solid rock, causing significant wear. This wear on solid rock continued until the scraper was sufficiently above the face that high spots would pass with little contact. Large muck chips then could pass under the scrapers, causing a new wear problem.

The full-face cutterhead did not allow visual observation of the shaft bottom. While boring, the operator could not observe the action of the cutters or performance of the flight conveyors, detect oversize muck or tramp iron before problems arose, nor judge the water flow to optimize the volume added. During maintenance or while searching for tramp iron or oversize muck pieces, the inability to see the complete shaft bottom greatly hampered efforts.

The construction of the cutterhead severely limited access for working on the flight conveyors, bucket elevators, cutters, and scrapers, causing the men to manhandle many components into place and frequently work without assistance. In addition, when considerable water was added, the cutterhead trapped large quantities of muck which had to be washed out before maintenance work could be done.

The full-face cutterhead is a massive structure which complicates removal of the BSB from the shaft and requires two trucks for transportation between shaft sites.

6.2 Mechanical Muck Pickup Systems

Performance and wear indicated that the Seattle test conditions were not comparable to conditions encountered while boring the shaft in Alabama. The Robbins test fixture used one stationary flight conveyor bucket elevator system, rather than two rotating systems. Flight conveyor jamming early in the project indicated problems in transferring flight conveyor design to the BSB.

Seattle test conditions for Robbins' testing of the muck system were considerably better than those found on the BSB. Visual observation of the entire muck pickup system was possible and minor problems could be rectified before they shut the system down. Test components were easily accessible for maintenance and modifications. In contrast, the BSB muck system could not be fully observed while in operation, and access for maintenance and major repairs was severely limited. The limited access led to components being assembled in place rather than on the surface. Often the limited access allowed working room for only one mechanic, making the job difficult and time consuming. The flight conveyors were difficult to maintain and replace.

BSB component wear and problems with oversize material indicate that the muck handled in the Seattle test was not comparable to that encountered on the job. The Seattle units experienced insignificant wear, indicating the muck was less abrasive. The muck size apparently was smaller because jamming was not a problem even when operating in the dry mode, while the BSB required the addition of considerable water for flight conveyor operation without excessive jamming.

If water content of the muck dropped too low, its combination with the excessive fines from regrinding resulted in a sticky paste which plugged the flight conveyors and the bucket elevators. The sticky muck had to be removed by hand, so removal was a time-consuming process.

The BSB muck system exhibited a lack of power and capacity which can, to a minor degree, be explained by the volume of water used, whereas most test work was with relatively dry muck. Differences between the test fixture and BSB installation account for most of the discrepancies.

The fixed scraper wear, noted earlier, further downgraded the bucket elevator performance.

6.3 Hydraulics

Many of the problems can be traced to the use of a mechanical muck system that was designed on the basis of feature testing which was unrealistic in light of actual BSB performance. The power requirements of the mechanical system were significantly underestimated, and the BSB hydraulic system did not have sufficient reserve capacity to reliably provide the power actually required. The operation of the bucket elevator and flight conveyor hydraulic circuits at higher than recommended pressures for fire-resistant (FR) fluid did marginally improve performance but reduced component life and increased downtime.

The system was complex, with several circuits interconnected for provision of features to enhance overall BSB performance. The complexity and interconnections proved detrimental, as hydraulic problems could not be readily found and corrected. Also, the system had virtually no redundancy, and hydraulic problems could not be addressed with the BSB in operation, which resulted in downtime.

Pressure requirement of more than 3,000 psi for the gripper circuit was a problem. It could have been achieved in the field by use of an intensifier or an air-operated piston pump. Either would have allowed the higher pressure to be maintained without reducing pump life. This would have resulted in a reduction of downtime.

Different parts of the hydraulic system operated at different pressures achieved through the use of pressure reducing valves. A design for operation with one pressure or perhaps at most a high and a low pressure would have had numerous advantages. Even then, the high pressure should have been significantly lower than the 2,000 psi recommended for FR fluids. The pressure reducing valves were a continual source of problems and should probably not be used with FR fluids. They were subject to wear, plugging, and erratic operation and are suspected of causing the FR fluid emulsion to break down.

The hydraulic system design did not seem fully compatible with FR fluid in that many components suffered internal damage from rusting, corrosion and pitting of machined surfaces. The severity of these problems may have been increased by the frequency and durations of BSB shutdowns. It is known that shutdowns during cold weather contributed to pump cavitation and subsequent failure. The ability of the FR fluid to adequately lubricate and prevent wear of the rotating components in piston type pumps and motors was questionable.

Many of the problems could have been solved by modifications by the operating contractor. Since the time used for regripping was insignificant, an air operated piston pump with a separate hydraulic tank could have been installed. This pump would reliably handle fluid pressures of 5,000 psi, and the separate tank would ensure that any fluid breakdown due to high pressure

would be confined to the gripper circuit.

Air-driven pumps could have been installed to power the propel and side support cylinders with the pressure of each circuit independently controlled by regulating the air pressure supplied to the hydraulic pump.

The flight conveyors and bucket elevators could have been repowered with either an adequately designed hydraulic system or an air motor driven system. The hydraulic system would have included larger drive motors, new gearboxes where required, and the use of pumps that are satisfactory for use with FR fluid. To repower with air motors would have required new gearboxes and provision for four independent compressed air lines through a swivel. The air motors would have eliminated the electrically driven hydraulic pumps, associated electrical controls. They are quite rugged and dependable.

6.4 Lubrication

The lubrication system for a blind shaft borer must be different from that of a tunnel borer in that the cutterhead drive gearboxes are vertical and cannot use a splash lube system. Also, the main bearing and bull gear operate in a horizontal plane, rather than vertical.

The lubricating system installed on the BSB, for the required pressure and flow, was very complex and physically excessively large. The use of a lube oil tank required the use of a lube return pump. The complexity was increased by the use of an electric motor driven hydraulic pump powering a hydraulic motor driven lubrication pump which supplied 600 psi lube oil

to six gearboxes (1.125 gpm each) and to three locations on the main bearing (0.56 gpm each). A similarly powered lubrication pump was used to return the oil from the bull-gear main bearing cavity to the lube tank. This seems to be overkill for such simple lubrication requirements, considering that the sump had adequate capacity to serve as the reservoir and that the lubrication circuit could have utilized simple, proven, commercially available air-driven pumps.

The BSB lubrication system also had a contamination problem. In retrospect, some of the problem might have been foreseen when water had to be removed from the lubrication system when the BSB reached 108 feet (61 feet of boring). The contamination problem became quite apparent during the last 200 feet of boring. Contamination of the oil with muck was evident by the high silica content that was detected when the oil was analyzed. The inner seal on the cavity was suspect so efforts were made to keep muck from getting on top of the seal. Actual inspection of the seal was considered impractical because the access through the inner tower was limited. Inspection of the seal after demobilization revealed that a piece was missing.

6.5 Electrics

For a truly universal machine, a contractor (construction or mining) would prefer the portability of diesel, diesel powered hydraulic or air-driven equipment because the preparation for storage or shipment of these items is very simple compared with permissible electrics.

With the high BSB down time, the transformer could have been de-energized and the galloway repositioned to better serve its intended functions.

The permissible electrics did not function well in the BSB because the environment was wet and dirty even though the shaft was considered to be relatively dry.

6.6 Guidance

Data indicate that the shaft was bored within one inch of true centerline, with the exception of one excessive deviation which was caused by an adjustment error in setting the "look ahead" position.

The operator, who was busy keeping the flight conveyors working and continuously steering the BSB, was overwhelmed when the guidance display was even momentarily interrupted.

Considerable operator time was spent steering the BSB. The resulting shaft accuracy was excellent but beyond normal requirements. The operator's time might have been better utilized with less emphases on steering.

No rock formations were encountered that would have caused the BSB to deflect, but if such formations had been encountered, it is possible that the operator might have had difficulty in comprehending the directional display readouts.

Steering of the BSB would have been less accurate if the BSB had penetrated at the design rate (or the operator would have had to spend an even higher percentage of his time steering).

The three-point cutterhead suspension and steering provided positive control and good response time, but the machine

position was displayed on a quadrant so the operator was forced to make mental conversions and continually adjust the control valves.

It was concluded that the practical limit for the laser beam was 300 feet. No guidance problems were encountered on the BSB project until longer ranges were attempted.

Many of the forming and lining problems were associated with the inability to do this work while boring because of blockages of one or both laser beams.

The project location near Birmingham, Alabama, a major city servicing the mining industry in the southeast United States, provided considerable local expertise which was not used.

The project location allowed easy access to services for parts and repairs which lessened the demands on inventory control and project management for the complicated BSB. The BSB must be simplified if it is to be used satisfactorily in remote locations and reliable performance is to be expected. If not simplified, the on-site inventory of parts and quantity and quality of technicians required to keep the BSB operational will make the project uneconomical.

The blockage of the lasers with the rear shield and gripper ring was not a major problem. However, if the shaft had been located elsewhere with strata subject to sloughing or voids, the problem could have been significant. The lasers' beams should be relocated or provisions made for a complementary system to cover this type of problem.

Laser beam divergence became unacceptable when the distance was extended considerably beyond 300 feet. The decision

to use underground permissible lasers (thereby shortening the distance) was unnecessarily delayed, causing a considerable loss of boring time. After the conversion, one of the underground units failed and a rental unit was obtained. The rental unit had its lense mounted at the end of the tube where it was subject to blockage by water-splatter. Again, considerable downtime occurred before a decision was made to eliminate the problem rather than frequently stop boring and clean the lense.

The rental of three battery-powered permissible underground lasers would ensure reliability. The spare would ensure minimum downtime in case of a failure, and the failed unit could be exchanged for an operational unit to be used for the spare.

6.7 Skip Hoisting

The use of skips for hoisting resulted in varying amounts of spillage at the loading point. The spillage was caught in a sump which was periodically cleaned. This spillage could have been channeled into the shaft bottom.

The shaft conditions and muck consistence were not foreseen in the design stages. Had muck with 50 to 75 percent water and a considerable volume of fines been expected, it is doubtful that a bottom or side dump skip would have been used.

The hydraulic cylinders and muck measuring hopper door were also designed for different muck conditions. For the conditions encountered, an air-operated, upward thrusting guillotine door would have provided more reliable service.

The probes for signaling a full hopper were not reliable in the encountered muck conditions.

The use of the two independently operated carousel doors with interlocks was complex and did not prevent both doors from being closed, forcing muck to overflow into the space between the inner and outer tower. When that occurred, an electrician was required to make the hoisting system operative. If the two carousel doors had been mechanically linked for operation, the skip hoisting interlock circuitry could have been simplified.

The wet muck and volume of fines encountered resulted in heels of muck forming in the measuring pockets. The use of steeper sides would provide some benefit at the cost of increased height. However, considering the time required to fill a hopper on the BSB and the vibrations of operations, the muck would have built up to some extent in any style hopper, unless the bottom was larger than the top and opened completely.

6.8 Time Utilization

At least one walkout of the miners (UMW) was a result of a lack of management response concerning an alleged unfair scheduling of weekend work. Better communications would have led to a more stable work force and better worker morale.

In shaft work, the miners are hoisted to surface for lunch because underground space is at a premium and facilities are not provided. Thus, a 30-minute lunch combined with hoisting time resulted in an hour of BSB downtime, which immediately reduced utilization to a maximum of 81 percent. This has a direct effect on the economics of operation and

perhaps alternative lunch plans should be examined. Lunches could be staggered or shorter shifts without a lunch hour could improve utilization.

The use of trucked-in, ready-mix concrete combined with two-shifts-per-day operation resulted in significant amounts of time being poorly utilized.

The galloway was of limited benefit because it was required to be stationary while the BSB was boring. The BSB position and design prevented its use while pouring concrete because it could not be positioned at form height.

The BSB and supporting systems were designed on the basis of considerably fewer problems and little, if any, redundancy was built in. This, coupled with ineffective preventive maintenance, led to the BSB being frequently shut down for repair.

On many occasions, the BSB downtime was significantly increased while waiting for parts. Additional downtime resulted from planned conversions going awry when new components did not interface properly.

The rented front end loader, dump truck and boom truck from the contractor received little use due to the poor BSB advance rate. Outside contractors were hired on several occasions to do work that, with improved scheduling, could have been handled with project men and equipment.

6.9 Maintenance

The design of the BSB caused the contractor to spend considerable time cleaning muck spilled from the hoisting operation and concrete spilled during the lining operation.

Since few activities were carried on concurrently with BSB cleanup, this task significantly impacted time available for boring. The use of redundant systems could reduce BSB downtime for the same maintenance time requirement.

The emphasis on designing underground equipment should be on simplicity. Simplicity would significantly decrease maintenance time and improve quality of work. This is particularly true in shaft sinking, where all necessary equipment and tools must be lowered for working on the BSB and removed after the repairs are made.

The major components should be designed for replacement as a complete unit. The downtime for maintenance would be reduced to the time required to exchange units. The unit to be repaired would be worked on, or modified, and tested in good working conditions on the surface. Thus, when a spare unit was installed on the BSB, it would be fully operational within minutes of completion of the installation.

6.10 Safety

An emergency hoist should have the capability of evacuating all personnel, including stretcher cases, from an assembly point in a minimum of time. The assembly point must be easily accessed by both the men and the hoist, which was not the case with this design.

The shaft miner is totally dependent on the operation of the hoisting or emergency hoist whenever circumstances require evacuation of the shaft. The shaft miner is trapped without a safe sanctuary and most often without a ladder way to surface. The possibility of climbing out of a shaft under construction is very remote.

The man cage, as used during the BSB field trial, was not as safe as it should have been. The door was frequently opened while the cage was still in motion.

Mine safety codes vary from state to state, with some more stringent than MSHA codes. If the BSB is to be accepted as a contractor's tool, it must be usable in all states and preferably worldwide.

The man cage did not meet safety codes of several states and could not be used in those states without significant changes to provide protection in the event of a broken rope.

Mines typically do not use horizontal sliding doors such as the one used on the man cage because they are a continual source of problems, require significant maintenance, and do not lend themselves to foolproof safety interlocks.

The use of the BSB in colder climates will cause additional problems, unless measures are taken to heat the incast air. If the colder air is not heated, worker performance and attentiveness will be reduced and operational safety will decrease. Also, if the air is not heated, the workers would be tempted to shut down the incast fan to decrease the air velocity during maintenance operations, thereby increasing methane risks.

The codes do not require access from the shaft bottom to the galloway by means other than the hoist; however, a ladder from the BSB to the galloway would provide an alternate route and free the hoist for other tasks.

6.11 Organization and Communications

Operational problems often were not identified or solved on the jobsite. Consequently, the BSB performance dropped and, frequently, the BSB was down waiting for a home office decision on how to handle the situation.

The project sponsor (U. S. Steel) was not kept abreast of the progress, problems and future planning. Had good communications been maintained with the sponsor, it is possible that some of the shutdowns could have been avoided.

6.12 Stream Contamination

The poor performance of the flight conveyors and scrapers resulted in excessive regrind of the cuttings and continuous use of a large volume of water. The resulting slurry exceeded the capacity of the original ponds, required additional ponds, and was a source of justifiable criticism from U. S. Steel.

6.13 Grouting and Concrete Lining

The test hole drilled before the shaft was started identified the rock strata and the location of water bearing formations. This gave the operator advance information on rock conditions and grouting requirements.

The formations the shaft penetrated were self-supporting. The coal seams could have been shotcreted, as they were in the nearby U. S. Steel shaft sunk by Cowin.

Several shafts in the immediate vicinity were sunk to the proposed depth without any wall support other than occasional shotcreting to seal coal seams. Therefore, it is concluded

the ability of the lining system to handle bad ground was not tested.

Small water inflows are normal in shaft sinking operations. The BSB must be capable of operating in them or of supporting the cost to control them. If not required by the sponsor, the contractor must justify the additional cost of water control through reduced maintenance or improved worker performance.

A BSB should have the capability of using temporary supports for bad ground. It should be possible to install steel sets, rock bolts and wire mesh or to shotcrete bad ground as soon as it is opened to the full shaft diameter.

The contractor attempted (for 500 feet of shaft) to use a standard concrete mix rather than adjust the mix formula to account for local aggregate type and shape, cement used, transportation time and other local conditions.

The sponsor shaft specifications called for 3,500 psi concrete for the liner. The concrete strength was checked by taking samples on the surface, but the liner was never cored to check the strength of the concrete as actually placed. Considering the problems during placement and appearance of the liner when the forms were removed, this was a serious oversight.

6.14 Mobilization

It was the manufacturer's intention that the BSB be built up in the collar with major subassemblies consisting of site assembled components. The collar was too small and out-of-round so assembly in the collar was required.

The headframe will not be essential if pneumatic hoisting system is used to transport muck from the BSB to the surface. Thus, the massive headframe would not be required and its transportation, mobilization, and demobilization costs could be avoided by use of alternate means of galloway support and man cage operation.

The BSB project headframe is not portable compared with a typical shaft sinking headframe.

The front shield design did not lend itself to assembly and disassembly within the confines of a shaft. The front shield is not a necessity in most shaft work and should be eliminated or extensively modified to eliminate potential problems.

6.15 Demobilization

The demobilization time was excessive. It is probable that removing the transformer from the galloway, simplifying the construction and using pins for fastening components could significantly reduce demobilization time. The demobilization time for the modified BSB will not significantly change; however, it is possible that a new design BSB could be hoisted out of the shaft in a single lift in one of two days. The headframe disassembly could be improved but best results would arise from its elimination. The surface work would remain about the same unless the number of hoists is significantly reduced.

All the BSB components were brought to the surface by the man cage or skip guide rope hoists and swung out of the shaft with an 80-ton crane. This required connecting the

crane to the components while they were suspended over an open shaft. All the components were double handled by the 80-ton crane, with the exception of the center portion of the cutterhead, which involved triple handling and the use of a 150-ton crane.

Unless other provisions are made, all materials going in or coming out of the shaft use the shaft cover as a landing and intermediate transfer point. The cover has to be strong enough to support the heaviest component and yet have the capability to open up sufficiently to pass the largest fabrications.

SECTION 7

ALTERNATIVE MUCK HANDLING SYSTEMS

Before the BSB was placed in operation, several shortcomings of the skip hoisting system were recognized and an investigation into pneumatic hoisting began. After the BSB was operational, additional problems were noted, many of which would not occur with a pneumatic hoisting system. This increased interest in the alternative so the DOE contracted for additional testing.

The use of a vacuum system for primary muck removal from the face had been considered but rejected in the early design stages. When the BSB began operation, severe problems were encountered with the mechanical muck pickup system. This revived interest in the vacuum pickup system, and a feasibility study was initiated based on the revised job requirements. As the problems with the mechanical system continued, it was decided that a preliminary vacuum test was justified. The preliminary results were encouraging, and work was continued on the design, fabrication and testing of a retrofit unit for the BSB.

Unfortunately, delays in testing the vacuum system, combined with U. S. Steel's request for termination of BSB boring, resulted in neither the pneumatic hoisting system or the primary vacuum pickup system being installed on the BSB for actual field testing.

7.1 Pneumatic Hoist System

The investigation into using a pneumatic hoisting system (PHS) with the BSB was initiated when several shortcomings of the skip hoisting system became apparent. During the first phase of the PHS development, Radmark Engineering of Portland, Oregon, examined the technical and economical feasibility of utilization of the BSB. They prepared a preliminary design and, since the space constraints of working in a shaft required significant changes from their normal installations, a 1/8 scale working model was built. The model was used in testing variations in airflow, material throughput, types of material, and size of material to determine the limitations imposed by the restrictive configuration of the existing BSB.

The test results indicated that positioning the upcast elbow adjacent to the material feeder did not significantly degrade performance and that a full-scale system would work and meet performance expectations. The preliminary investigation and satisfactory performance of the model led to a full-scale preliminary design.

Radmark was contracted to develop and test a full-size PHS for use on the Robbins BSB. The earlier full-scale preliminary design was upgraded to ensure compatibility with the BSB and fabrication of components started.

A suitable location for testing was found at the Bethlehem Steel, Grace Mine near Morgantown, Pennsylvania. The shaft was nearly the same diameter as the one being bored by the BSB. It was more than 1,200 feet deep, allowing the system to be tested under conditions similar to those encountered by the BSB.

The shaft and collar area were prepared and the downhole equipment was installed at a depth of 1,250 feet. Since the BSB is continually in motion, provisions were made to simulate the motion and ensure that test results would be realistic.

The surface equipment was installed and the wire ropes to support the pipes were run through the Lucker rope handlers and attached to the pipe support platforms. The air feed pipe (22-inch diameter) and air hoist pipe (16-inch diameter) were then lowered, section by section, until connections were made with the downhole equipment. A 12-inch diameter rock return pipe was hung in the shaft by conventional means.

The operational controls were installed at the 1,250-foot depth to simulate operation from the transfer deck of the BSB. The controls included the capability of starting and stopping the surface located blowers, controlling the drive of the air lock feeder and the amount of material fed into the system.

The system performance was evaluated by recording the air pressure within the system and the weight of material handled with a conveyor scale.

The rock to be hoisted with the PHS had to be recirculated because there was no rock supply available at the 1,250-foot depth. The drop pipe carried rock from the surface down to a storage bin from where a vibrating feeder fed it into the PHS airlock feeder. The PHS conveyed the rock to the surface and discharged it into a collection bin from which the material dropped onto a conveyor for return to the drop pipe.

To conduct a test, the underground storage bin was filled and the weight conveyor, the blowers and the airlock feeder were started by the underground operator. When the system

pressure stabilized, the vibrating feeder was started and the rock was fed into the system through the airlock feeder. The feed rate started low and the rate was gradually increased until the system maximum was approached. The operator attempted to maximize the rock feed rate without actually overloading the system. If the system was overloaded, the pressure cut-out switch would automatically stop the vibrating feeder, stopping the flow of material into the airlock feeder, which would allow the system to clear itself.

Each test run lasted only 10 to 20 minutes because degradation of material and loss of fines left insufficient material to keep the system at capacity.

To determine the operating costs, the relationship between power consumption and tonnage was developed. A power versus pressure relationship was determined by partially blocking the exhaust pipe. This curve was then combined with a pressure versus tonnage curve from the lifting tests to generate the desired power versus tonnage relationship. The data showed that the nearer the system is operated to capacity, the lower the unit cost for material hoisted.

The test results confirmed that a PHS could continuously lift in excess of 150 tons per hour. The mobilization of the system can be accomplished in four days, which is a significant improvement over the skip hoisting system. The PHS system will handle material of different moisture contents and, since it is a closed system, any muck spillage or dust problems are eliminated.

The use of the Pneumatic Hoisting System is recommended.

7.2 Vacuum Pickup System

The investigation into using a vacuum system for primary muck removal from the shaft bottom was shifted from an item of low interest to one of prime importance when the mechanical muck system continued to be plagued with problems.

The original Radmark contract required evaluation of the technical and economical feasibility of applying pneumatics to muck pickup from the cutting face of the BSB. During the course of the contract, this was changed to a requirement to design, build and test a vacuum muck pickup system that would work on the BSB.

To determine the feasibility, the original Robbins BSB test fixture in Seattle was modified. A vacuum pickup head was suspended above the rotating bowl. A vertical 10-inch pipe rose from the head and entered the first of two cyclones, in series, where the rock was separated from the air stream. From the second high-efficiency cyclone, the clean air was piped into two Gardner-Denver blowers plumbed as vacuum pumps. A multiple V-belt drive system transferred power to both blowers from a Detroit Diesel engine. The rock was fed out of the first cyclone with an airlock feeder and dropped back into the bowl.

The system performance was determined by measuring the volume of rock approaching the pickup head, subtracting the volume not picked up, and using the density to get the weight of the material lifted. This was combined with the table velocity under the pickup head to determine the pickup rate in tons per hour.

Several different materials were tested. The results indicated that a vacuum pickup system was effective and that further testing was warranted.

The vacuum test facility was redesigned to the configuration necessary to fit on the BSB and to lift the tonnage required for a satisfactory BSB penetration rate. These changes required doubling the capacity of the system and changing the flow path to come down the center of the BSB through a rotating joint and out to the muck pickup area by using elbows. The rotating joint was not available in time and was not included in the testing.

The continuous operation was refined with a conveyor scale weighing the discharge from the airlock feeder before returning it to the bowl.

The second series of tests were run using a pickup head mounted on a telescopic joint, which allowed the head to be quickly raised 8 to 9 inches above the bowl face. The majority of the vacuum pickup tests were run with this arrangement and the results were excellent, although considerable wear was encountered in the lower elbows. The wear was significant, but the use of proper elbow material should render it insignificant to overall BSB operations.

A short series of tests were conducted using a rigid head with an adjustable throat plate. The operation of this head was satisfactory but it did not provide the operator the same degree of control over muck pickup rate.

The vacuum pickup tests proved the viability of the system for use on a BSB. The results with various material sizes and moisture contents indicated the system would be tolerant of changing muck conditions, provided a sticky cohesive

mixture was not handled for more than one-half hour. The ability to add water ahead of the feeder (face, pickup head, cyclone entrance, or feeder inlet) will minimize this problem. The different heads used indicated that the physical shape is not critical so long as the side skirts are close to the face (1" to 2"), the inlet throat close to the top of the muck furrow, and the rear gate for bypass of oversize or overfeed is closed. This causes high velocity air to sweep the face under the pickup head, which results in efficient face cleaning.

INTRODUCTION

The Project Log is a review of the day-to-day operations of the BSB. A review of the Radmark testing of a vacuum muck pickup system also is included.

This summary of significant events was taken from the daily reports written by Williams Brothers Engineering Co. personnel on the BSB field trial site in Alabama and the vacuum pickup testing site in Seattle Washington.

The observations of the BSB field trail began during assembly of the BSB in the shaft collar and continued through demobilization of surface facilities in preparation for completion of the shaft by conventional excavation.

All aspects of the BSB site activities were monitored. The activities included boring, shaft lining, extension of service lines, and maintenance of the muck handling, hydraulic, lubrication, electrical and skip hoisting systems. The disposal of muck and treatment of waste water also were monitored.

The vacuum muck pickup test were monitored and evaluated to determine the possibilities of retrofitting the system onto the BSB to aid in the completion of the shaft. Two test periods of the Radmark system were monitored. The first was the startup and preliminary testing of the system in June 1980 and the second period was when the actual tests of the system were made from November 1980 to January 1981.

PROJECT LOG BOOK

November, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	1	47		Installed 30-inch ventilation fan and piping.
2	1			Continued assembly of the BSB in the shaft collar and galloway on surface.
3	1			Connected both electrical and hydraulic systems.
4	1			Started piping 36-inch ventilation system.
5	0			Sunday, no scheduled work.
6	1			Continued assembly of the BSB.
7	1			Connected 950-volt wiring to BSB and checked both hydraulic and electrical systems.
8	1			Ran hydraulic systems and tightened connections to eliminate all leaks.
9	1			Mounted surface laser gun brackets.
10	1			Roped skip guide winches.
11	0			Veteran's day, no scheduled work.
12	0			Sunday, no scheduled work.
13	1			Formed and poured emergency hoist pad.
14	1			Checked electrical system in preparation for the MSHA inspection and certification.
15	1			Made minor electrical changes as required by the MSHA inspection.
16	1			Continued assembly of BSB and galloway.
17	1			Installed emergency hoist.
18	1			Roped auxiliary winches. Started assembly of headframe.
19	1	47		Sunday, no scheduled work.

PROJECT LOG BOOK

November, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
20	1	47		Completed all MSHA required electrical modifications.
21	1			Continued assembly of BSB and galloway.
22	1			Completed outside construction of hoist house.
23	0			Thanksgiving, no scheduled work.
24	0			Thanksgiving weekend, no scheduled work.
25	0			Thanksgiving weekend, no scheduled work.
26	0			Thanksgiving weekend, no scheduled work.
27	1			Continued assembly of BSB and galloway.
28	1			Repaired hydraulic reversing on flight conveyors.
29	1			Rearranged hydraulic hosing on bucket elevators to make them operative.
30	1	47		Adjusted and aligned BSB-mounted laser targets.

PROJECT LOG BOOK

December, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	47		Continued to check all BSB systems. Installed second laser target. Beveled edges of the flight conveyor paddles so they would not interfere with the outer wear plates.
2	2			Fabricated and installed skid plate and two idler rollers.
3	0			Sunday, no scheduled work.
4	2			Modified laser beam target brackets. Attempted to determine BSB steering and leveling problems. Continued debugging sensors on the BSB and interface with surface computer.
5	2			Attempted to bore but both flight conveyors jammed. Spent remainder of day resetting pressure reducing valve on the hydraulic flight conveyor chain tensioners and checking hydraulic circuitry to determine cause of jamming. Checked periodically for methane gas at several locations.
6	2			Continued to have problems with the flight conveyors jamming and steering of the BSB. Set Sunstrand flight conveyor pressure to 2750 psi and pressure relief valve to 3,000 psi. Removed cap from the the propel cylinder return line. Checked for methane gas. Reduced bucket elevator from 48 to 35 rpm.
7	2	47		Identified steering and leveling problem. One bank of cylinders did not respond to the other's demands. Flight conveyor wear plates were bent thereby reducing clearances for the chain paddles. They were straightened. Bored several inches in gravel.

PROJECT LOG BOOK

December, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
8	2	47		Checked for methane gas 10 times at the bottom of the shaft. Jacked bent No. 1 flight conveyor guide plate back into position. Bored several inches in gravel. Both flight conveyors jammed. Replaced O-ring on one flight conveyor directional valve in console. Continued assembling headframe. Checked for methane gas.
9	2	47		Reset both relief valve pressure and time delay on the flight conveyor automatic chain reversing system. Flight conveyors still jam. Installed all concrete forming rings in the shaft. Dewatered shaft. Checked for methane gas, and as in the past, all readings were negative.
10	0	47		Sunday, no scheduled work.
11	2	47		Bored approximately five inches and made the transition from gravel into rock. Flight conveyors were still giving problems. Installed hanging rod brackets in shaft.
12	2			Attempted to bore in rock but flight conveyors jammed almost immediately. Replaced ground check system relay on electric motor driving No. 2 flight conveyor and one half of skip loading system. Straightened bent flight conveyor wear plates. Increased pressure on bucket elevator cross relief valves to prevent stalling.

PROJECT LOG BOOK

December, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
13	2			Bored several inches. Replaced the inoperative hydraulic-over-air valve that actuates the clutches on the cutterhead drive motors. Cleared jamming flight conveyors by backing the cutterhead off the face and rotating the head with the inching motor. Fabricated a mechanical chain tensioner for No. 2 flight conveyor. Continuing with assembly of headframe and concrete forms.
14	2			Bored dry with minimal progress. Added water to the face and increased performance to 18 inches in two hours. Retrofitted mechanical for hydraulic chain tensioner on No. 2 flight conveyor. Schmidt and Uthus of DOE, Sands of USBM (TPO) and Hynd and Salter of Cementation met to discuss project overruns.
15	2			Continued to experience flight conveyor jamming. Thinking is that the muck swings the paddles up to catch on the side wear plates. Braces were made to make the paddles rigid. Tested several times for methane gas. Muck decreased in size indicating that the larger cuttings were the product of boring through blasted rock.
16	2			Retrofitted mechanical for hydraulic chain tensioner on No. 1 flight conveyor. Bored alternately with and without water. Established that the flight conveyors jammed when attempting to dry up the face and ran freely whenever water was introduced.

PROJECT LOG BOOK

December, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Freed four feet of muck that had built up inside the inner tower.
				Repaired one and tightened the other oil mist lubricators to the flight conveyor chains.
17	0			Sunday, no scheduled work.
18	2			Installed bar on leading edge of flight conveyor to hold down the chain.
				Started boring. Flight conveyors jammed immediately. Experimentally confirmed that an empty flight conveyor could be stalled by throwing a handful of gravel into the idler sprocket. Designed and fabricated idler sprocket deflector shields.
				Replaced propel cylinder gage.
				Installed rebar in preparation for pouring concrete.
19	2	2		Installed idler sprocket deflector shield.
				Started boring but flight conveyor would not lift muck to buckets. Decreased flight conveyor from 48 to 30 rpm and increased bucket elevator from 48 to 55 rpm.
20	2			Modified idler sprocket deflector shields.
				Shimmed idler rollers 1/8-inch to give the chain additional clearance. Replaced one broken roller.
				Poured curb ring.
21	2			Disassembled, cleaned and shimmed idler rollers to give additional 1/16-inch clearance.
				Assembled both flight conveyor roller assemblies. It did not solve the problems. The flight conveyor continued to jam immediately at start-up.
22	2			Attempted to bore but both flight conveyors continued to jam. BSB was continuously muckbound.
				Hand mucked cutterhead and inner tower.

PROJECT LOG BOOK

December, 1978

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
23	1			Mucked and washed BSB. Dewatered shaft. Drained all service lines. Prepared BSB for shutdown during the Christmas Holidays.
24	0			Sunday, no scheduled work.
25	0			Christmas, scheduled shutdown for holidays.
26	0			Scheduled shutdown for holidays.
27	0			Scheduled shutdown for holidays.
28	0			Scheduled shutdown for holidays.
29	0			Scheduled shutdown for holidays.
30	0			Scheduled shutdown for holidays.
31	0			Scheduled shutdown for holidays.

PROJECT LOG BOOK

January, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	0			New Year's Day, project shutdown for the holidays.
2	0			Checked BSB after shutdown. Cleaned site and hoist house.
3	0			Oiled concrete forms on surface. Cleaned concrete spills after last pour.
4	2			Friant and Moffat of Robbins arrived on the jobsite to solve the flight conveyor problems. They concluded that the jamming occurs as the muck slides down the flight conveyor bottom and into the idler sprocket. Removed chain from No. 1 flight conveyor.
5	2			Welded the paddles to the links of a new chain and beveled the upper edges of the paddles. Scarfed metal around the flight conveyor idler sprocket to provide additional clearance. Installed idler sprocket and modified chain on No. 1 flight conveyor frame. Modified the No. 2 flight conveyor chain in the same manner as No. 1 was modified. The change was made without removing the chain. Scarfed out the accessible front end of the frame around the idler sprocket.
6	2			Increased flight conveyor rotation speed from 28 to 35 rpm and bucket elevator from 25 to 35 rpm. Started boring and both flight conveyors jammed immediately. Determined that the idler sprocket teeth were not meshing with the chain. Burned the teeth from the No. 1 flight conveyor idler sprocket. Attempted to bore dry while determining bucket elevator performance at different speeds. Confirmed that the bucket elevators would operate at speeds up to 63 rpm in dry muck and would empty the buckets in the inner tower instead of the carousel at speeds in excess of 38 rpm in wet muck.

PROJECT LOG BOOK

January, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	0			Freed the muckbound flight conveyors. Moffat and Clay of Robbins left for Seattle. Sunday, no scheduled work.
8	2			Cleaned inner tower. Replaced the electric-over-hydraulic solenoid valve on the bucket elevator. Identification of the problem took most of the work day.
9	2			Checked for methane gas. Continued to clean inner tower. Capped all water outlets to the shaft face. Installed a one-half inch water line to each of the chutes at the interface of the bucket elevators and flight conveyors.
10	2			Installed muck deflector in the bottom of the inner tower. Checked hydraulic system to determine reason for inadequate control of the propel cylinders. Steering is one of the several functions of the propel cylinders and it is accomplished by pressurizing all three banks of cylinders and bleeding the excess volume from individual banks.
11	2			Bored 17 inches in 3.5 hours. Flight conveyor speed was 48 rpm. Bucket elevator speed varied from 48 to 60 rpm. Dumped 12 buckets of muck. Six were 75 percent water, two were 50 percent and four were 25 percent.
12	2			Bored for 45 minutes. No. 1 flight conveyor jammed. Determined that the chain would not stay aligned on the idler sprocket. Cleaned, reinstalled and tensioned chain.

PROJECT LOG BOOK

January, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Bored an additional two hours while attempting to make the transition from wet to dry muck. Both flight conveyors became muck bound. Tried to free the muck by continually changing direction of the flights. Of the four buckets of muck dumped, the first two were 50 percent water and the remaining two were 10 percent water.
				Removed No. 2 flight conveyor chain.
13	2			Modified No. 2 flight conveyor by removing and replacing the front chain hold down roller with a wear plate. Since the chain paddles interfered, the plate was removed and the roller reinstalled.
				Moved the chain hold down roller to either side but the No. 2 flight conveyor continued to jam.
				Removed No. 2 flight conveyor chain because it had stretched so badly that it would not mesh with the idler sprocket. The chain had been operated 39 hours.
				Resoldered connection in the timing circuit of the operator console.
14	0			Sunday, no scheduled work.
15	2			Thawed equipment for four hours.
				Dewatered shaft.
				Installed new No. 2 flight conveyor chain. Removed the front roller and added a wear (skid) plate.
				Cleaned inner tower.
16	2			Bored for one hour. No. 1 flight conveyor became muckbound. Burned off the front roller and scarfed around idler sprocket to give more clearance.
				Tightened chain.
				Freed muckbound No. 2 flight conveyor.
				Shut down to clean both flight conveyors when the BSB lost water and became muckbound.

PROJECT LOG BOOK

January, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Rasmussen of Battelle arrived on jobsite to continue working on flight conveyor problems.
17	2	20		Poured 20 feet of concrete liner. Cleaned spilled concrete and concrete handling equipment. Experienced false low lubrication oil pressure alarm. Cleaned dirt from the pressure valve to the air clutches. Bored 58 inches in seven hours while General Electric service personnel were taking vibration readings of the BSB at two cutterhead speeds.
18	2			Replaced Dynex side support pump. Installed water spray bars inside the inner tower. Replaced the plugged flow control valve on the Rexroth propel cylinder. Bored one and one-half feet.
19	2			Bored 10 feet in seven hours. Reduced flight conveyor speed from 47 to 40 rpm. Attempted to bore dry but flight conveyors became muckbound during the transition. Bypassed the interlock that declutches the cutterhead drive motors when the gripper pressure is too low. Reset the air pressure regulator on the air clutches to 80 psi.
20	2			Continued to install rebar. Lowered and blocked all concrete forming rings in place.
21	0			Sunday, no scheduled work.

PROJECT LOG BOOK

January, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
22	2			Continued to install rebar. Replaced three buckets on bucket elevators. Removed one-half link from both bucket elevators. Calibrated methane monitors.
23	2			Continued to install rebar. Installed air vibrator in the chute at the interface of the flight conveyor and the bucket elevator. Installed roller guards on the inner tower to comply with MSHA. Experienced four-hour delay with visitors.
24	2			Dewatered shaft. Gaged cutters. Concerned about No. 1 flight conveyor picking up more muck than No. 2. Measured scrapers to determine if one side of the cutterhead had worn more than the other of if the flight conveyors were of different heights. Final assessment was that all was normal.
25	2			Installed and calibrated Volvo penetration pump. Faulty contactor on the No. 4 cutterhead drive motor frequently declutched the drive motors and eventually burned out, shutting off all the power to the BSB. Attempted to make transition from wet to dry boring using the air vibrators to help move the muck. Both flight conveyors became muckbound.
26	2			Poured curb ring. Tightened the flight conveyor chains. Attempted to bore wet but the chains jammed when empty. Determined that No. 1 flight conveyor chain was worn out after operating 33 hours and No. 2 at 26 hours. Removed both chains, skid plates (in place of front rollers) and roller assemblies.

PROJECT LOG BOOK

January, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
27	2			Burned off No. 2 flight conveyor idler sprocket teeth to leave stubs. Replaced No. 1 flight conveyor idler sprocket bearing. Installed No. 1 flight conveyor chain and added a lubricator to drip oil on the idler sprocket.
28	0			Sunday, no scheduled work.
29	2	20		Determined that No. 1 flight conveyor was operating at 35 rpm and 650 psi. Installed No. 2 flight conveyor chain. Increased the size of the air supply hose to the vibrators. Poured 20 feet of concrete liner.
30	2			Bored one foot in approximately three hours to break in the new flight conveyors. Both flight conveyors continued to jam and become muckbound. Shimmed both flight conveyor idler sprockets one-half inch. Replaced broken bucket on bucket elevator. Increased flight conveyor rpm from 36 to 48.
31	2			Bored eight feet in 10 hours. A vibration sensitive inching motor relay frequently shut the BSB down. The relay was bypassed. Kept flight conveyors freed by continually reversing chain directions.

PROJECT LOG BOOK

February, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	89		Bored one-half hour, flight conveyors jammed. Sheared No. 1 flight conveyor drive sprocket retainer. Decided to replace it at a later date. Replaced missing horseshoe-shaped front skid plate on No. 2 flight conveyor. Thawed frozen surface water system. Repaired No. 1 conveyor idler sprocket brace. Added two skip tubes. Serviced both flight conveyor gear boxes.
2	2	101		Repaired pump and made boring water available to BSB at 9:30 am. Bored 11 feet, 7 inches in nine hours, 20 minutes averaging 1.24 feet per hour penetration rate or 0.73 feet per hour for 16 hours (2 shifts).
3	2	101		Installed hanging rods and lowered concrete rings. Serviced BSB. Added one drum of lubrication oil and two drums of FR hydraulic fluid. Added 20 feet of west and 40 feet of east skip tubes.
4	0	101		Sunday, no scheduled work.
5	2	109		Bored 8 feet. Fabricated covers for the six cutterhead drive motors. Blocked in concrete form rings.
6	2	109	5	Poured curb and five feet of concrete lining. Removed 60 feet of west and 40 feet of east skip tubes from BSB.

PROJECT LOG BOOK

February, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	2	109		Spooled 3/4-inch wire rope on emergency hoist drum. Installed transformer on galloway. Visited by three people from TRW preparing report for DOE. Detected H₂S; alerted both Cementation and Battelle. Installed flares on top of the BSB skip tubes. Removed temporary scaffolding and manway from shaft. Dewatered shaft. Removed temporary ventilation tubing. Lowered galloway into the shaft. Installed lighting transformer on galloway. Installed one guide rope headsheave in headframe crown.
8	2	109	15	Lowered galloway six additional feet into the shaft with 150-ton crane. Added 30-inch and 36-inch ventilation pipes. Poured 15 feet of concrete liner to complete 20-foot cycle. Installed guard rails in headframe crown. Cleaned concrete spills.
9	2	109		Installed subcollar and collar steel. Positioned main portion of headframe on collar supports with 150-ton crane. Holes were enlarged so mounting bolts would interface with leg holes. Cleaned east skip BSB tube.

PROJECT LOG BOOK

February, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10	2	109		Added back legs to upright portion of the headframe. Installed crown deck on top of headframe. Started bolting the headframe components together. Continued assembling collar components.
11	0	109		Sunday, no scheduled work.
12	2	109		Shimmed under all legs to position and plumb the headframe. Continued bolting the headframe components together. Reinstalled flare on top of west skip tube. Fitted and repositioned subcollar steel to line up with the headframe and galloway. Dewatered shaft. Inflow of water was estimated at 2.5 gpm.
13	2	109		Grouted all headframe legs. Positioned shaft cover over hole to prevent men from falling into shaft. Installed mancage headsheave and two rope guide sheaves. Fitted floor gratings in headframe crown deck. Fabricated 36-inch ventilation line adapter. Welded concrete form plumb line brackets on subcollar steel. Vlasimsky and Peterson of WBEC visited site. MSHA checked and found no presence of H ₂ S.
14	2	109		Completed installing floor gratings in crown deck. Aligned and bolted shaft cover to collar steel.

February, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
15	2	109		Installed 36-inch ventilation line adapter. Strung manhoist wire rope over headsheave. Continued bolting headframe together. Wired BSB electrical components. Wm. Little (DOE) visited site.
15	2	109		Installed scroll plates on the main structure of the headframe. Started fabricating plumbing to ventilate transformer mounted on galloway. Socketed mancase wire rope. Strung skip guide ropes over galloway headsheaves in headframe deck crown. Cleaned west skip tube. Rigged staging in headframe to work on the skip chutes. Continued wiring of electrical components.
16	2	109		Installed skip chutes to divert the dumped muck from the skips to the pad on the north side of the headframe. Bolted steel bulkhead on the front legs of the headframe to prevent dumped muck from rolling back into the shaft. Socketed two galloway (skip and mancase) guide ropes. Dewatered shaft. Marovelli and Paone of USBM visited the site.
17	2	109		Threaded mancase guide rope through galloway sheave and dead-ended it into headframe. Installed crosshead between the two mancase guide ropes and attached mancase to hoist rope.

PROJECT LOG BOOK

February, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Socketed one galloway skip guide rope.
				Continuing wiring the BSB and bolting headframe.
18	0	109		Sunday, no scheduled work.
19	2	109		Threaded the first skip guide rope through the galloway sheave and dead-ended it into headframe.
				Installed ventilation tubing on the main transformer located on the galloway.
				Set counterweights on the skip guide rope tension beams.
20	2	109		Threaded second skip guide rope through galloway sheave and dead-ended it into the headframe. The galloway is now supported by the one, two-part mancage guide and two, two-part skip guide ropes.
				Adjusted brakes on man hoist.
				Repaired temporary ladders to the BSB.
				Continuing wiring BSB and bolting headframe.
21	2	109		Spooled 2200 feet of 1-1/8-inch diameter full lock coil rope on the east skip hoist drum.
				Installed limit switch on man hoist and socketed end of rope.
				Dewatered shaft.
				Continuing wiring BSB and hooking up ventilation to galloway transformer.
23	2	109		Spooled equivalent amount of wire rope on the west skip drum. Socketed end of rope.
				Hung east skip.
				Removed temporary staging from headframe.
				Dewatered shaft.

PROJECT LOG BOOK

February, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
24	2	109		Continued wiring BSB and installing ventilation to galloway transformer. Cleaned BSB. Hung west skip. Greased skip scrolls. Installed subcollar steel and wire rope rub boards on the shaft cover doors. Checked operation of skips.
25	2	109		Sunday, no scheduled work.
26	2	109		Installed cross braces on headframe. Bolted ladder to headframe and guard rails at collar. Indexed skips to the load and unload positions. Continued wiring BSB.
27	2	109		Installed emergency hoist boom. Installed covers over the six cutterhead drive motors. Installed three winches in collar of shaft. Fabricated and installed rubber lips where the skips and mancage ropes pass through the shaft cover doors.
28	2	109		Powered transformer on the galloway. Installed skip tube clean out pipes on the BSB. Cleaned BSB. Made both exhaust and intake ventilation fans operational. Erected chain barriers around hoists for safety and to prevent unauthorized persons from handling the sensitive components.

PROJECT LOG BOOK

February, 1979

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

Time usage during the one-month reporting period

(Calculated from information supplied by Battelle at
the end of the project specifically for this report.)

	<u>Hours</u>
Availability to bore	90
Maintenance	278
Total Project Time	<u>368</u>
Actual boring	16.5
Pour concrete liner	39

Accomplishments

	<u>Feet</u>
Total shaft bored	20
Total concrete liner poured	20

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	109		Removed hydraulic chain tensioners from bucket elevators. Cleaned both inside and outside of inner tower. Installed line winches in subcollar deck. Extended service (air, water and pump discharge) lines. Wired hoist safety and limit switches, signals and telephone. Dewatered shaft.
2	2	109		Installed mechanical chain tensioners on bucket elevators. Caulked space between inner tower sections. Extended 4" cleanout pipe from bottom of skip tubes through machinery deck and into cutterhead. Welded muck guard on west skip tube. Continued wiring hoist switches and the underground-to-surface communication system.
3	2	109		Welded muck guard in each skip tube. Completed waterproofing inner tower. Sealed cracks in mancage and skip doors with rubber belting. Started piping service lines in subcollar. Reset water pump which was washed downstream during rainstorm.
4	0	109		Sunday, no work scheduled.
5	2	109		Trimmed inner tower adapter flange to give the bucket elevators more clearance. Burned drain holes in inner tower to keep water off main bearing seal.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
6	2	109		Removed air vibrator and hoses from inner tower. Painted skip hoist. Wired door switches, lights and underground-to-surface communications. Tomlin and Morris of National Coal Board in England visited the site. Modified the bucket elevator mechanical chain tensioners. Reinstalled Victaulic bypass on the cyclone separator water line. Repaired washed out gravel road. Four Germans visited the site.
7	2	109		Jacked up inner tower and repaired hydraulic leak. Installed seals and skirting in east skip and hopper doors to control flow of muck and water. Drained approximately 35 gallons of water from lubrication tank. The water probably entered through the main bearing seal and into the main bearing and bull gear cavity. Dewatered shaft. Continued wiring hoist and safety switches.
8	2	109		Installed seals and skirting in west skip and hopper doors. Checked hydraulic hoses within inner tower for leaks. Piped service lines in subcollar. Washed out accumulation of muck between towers and top of main bearing seal.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
9	2	109		Adjusted east skip door so that the rollers will go into the scrolls when skip is in dumping position. Removed cover from inner tower cutters and located horseshoe shaped front skid that was lost from No. 2 flight conveyor one month ago. Welders closed all holes in the operator deck to keep the water off the electric motors in the machinery compartment. Water is seeping into the shaft from the west shaft wall approximately 15 feet above the bottom of the shaft.
10	2	109		Shimmed the guides so that the skips will trip the surface limit switches. Drilled and tapped 3/4-inch hole into the main bearing cavity. Drained all lubricating oil and changed filters. Added 2 drums of lubricating oil. Repaired flight conveyor chute. Installed additional belting flaps on the shaft cover and doors to minimize the flow of spilled muck and water back into the shaft.
11	0	109		Sunday, no work scheduled.
12	2	109		Replaced main breaker switch. No work was done in shaft for 1 hour. Welded covers on holes on north side of BSB. Welded 3/4-inch extensions on six removable scrapers. Installed air and water valves on galloway. Set Lilly controls on the skip hoist. Worked on lubrication system problems for 8 hours. Removed sticking and (apparently not needed) solenoid valve from system. Dewatered shaft.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
13	2	109		Added 4 drums of lubricating oil. Installed belting on mancage and west skip doors. Continued piping the service lines at the subcollar. Installed modified scrapers. Repaired No. 2 flight conveyor chute. Completed sealing transfer deck.
14	2	109		Installed water sprays at the discharge of each flight conveyor. Covered and sealed holes in the operator deck. Burned holes in machinery deck and welded in two, 6-inch drains to direct muck and water into face. Oiled all hoist and winch ropes. Cleaned inner tower and washed cutterhead. MSHA approved underground usage of transformer mounted in galloway. Utter and Hawkins of Bureau of Mines, Denver visited the site.
15	2	109		Replaced the Lambda 20-volt power supply with one rented locally. Power out for 4 hours. Worked on alignment of mancage to the BSB to keep cage from hanging up on the flare. Reamed and cleaned drain holes in inner tower. Cleaned scrap from around center cutter wheels in cutterhead. Fabricated and installed ladder from operator's position to machinery deck. Installed handrails on subcollar ladder.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
16	2	109		Worked on gravel road into site. Gaged 37 of the 56 cutterheads. Installed shaft water level indicator on BSB. Wired mancage signal system (bell cord). Repaired stuck east skip hopper chute. Respooled wire rope on emergency hoist drum. Continued piping subcollar service lines and wiring BSB.
17	2	109		Removed damaged No. 2 flight conveyor chute for repairs. Burned 6-inch cleanout holes in front shield. Repaired skip shaft cover doors. Removed and replaced the wooden wire rope rub strips on the shaft cover doors with belting. Adjusted both air cylinders on the shaft cover doors. Started installing guide wheel brackets on galloway. Worked on gravel road into site.
18	0	109		Sunday, no work scheduled.
19	2	109		Installed the repaired No. 2 flight conveyor chute. Adjusted flight conveyor water spray nozzles. Replaced cover over center cutters. Freed binding skip doors. Fitted rubber cover over motor control center. Completed electrical wiring. Extended 6-inch machine deck drains to outside of cutterhead with PVC tubing.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
20	2	109		Filled skips with water to test effectiveness of seals. The sealing and modifications did not contain the leakage. Jacked and shimmed the inner tower into place. Dried out grounded cutterhead No. 3 drive motor. Cleaned pothead. Cleaned corroded solenoid valves that operate carousel gates and hopper chutes. Installed slicklines. Two Germans visited the site. Met with Friant of Robbins, Smith of Paul Weir and Henderson of Cementation.
21	2	109		Installed IR whirly pump and dewatered shaft. Installed guide roller on galloway. Serviced and hooked up surface concrete hoppers to slicklines. Replaced previously installed inner tower shims with thicker shims.
22	2	110		Bored 1 foot. Flow control on the Dynex propel pump stuck. When the hopper chute opens into the skip and as the skip dumps on the surface, the muck surges and spills. Built temporary block walls to contain the muck slurry on the surface pad. Modified surface concrete hoppers to accommodate chute from redi-mix truck. Reconnected 30-inch ventilation pipe that pulled away at the joint. Installed guard rails on galloway. Snoby of Dravo visited site.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
23	2	112		Met with Friant of Robbins to discuss future work. Freed Dynex propel pump. Replaced fuses on motor circuit in the east skip guide rope tension winch. The east skip drum brake was slow in releasing, causing the automatic rope tensioning beam to put too much load on the electrically braked winch. Prepared elephant trunks and galloway concrete hoppers for concrete. Piped Aldrich clear water pump to pump discharge line. Bored 3 feet. BSB is covered with spilled muck. Met with Friant of Robbins and Singer of Cementation.
24	2	115		Replaced No. 2 flight conveyor chain that had apparently walked off the drive sprocket. Dried and cleaned corrosion products from the pothead of cutterhead No. 3 drive motor. Replaced rotating air line union that was causing the air actuated clutch to slip in the cutterhead No. 1 drive motor. Increased air clutch pressure from 75 to 85 psig. Attempted to identify cause of vibration of the surface mounted suction fan. Replaced fuse on motor circuit in the east skip guide, rope tension winch. Cleaned BSB. Met with Friant of Robbins.
25	0	115		Sunday, no work scheduled.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
26	2	115		Completed hooking up Moyno (dirty water) shaft dewatering pumps. Dewatered shaft. Completed installing galloway guide rollers. Installed self rescuers on the BSB and galloway.
27	2	115		Started laying concrete block wall around the surface muck pad. Relocated galloway rollers from bottom to center deck. Changed surface exhaust fan. Blocked in rings and 10 feet of concrete forms. Dave McLean, new project manager for Cementation arrived on site.
28	2	115	10	Poured 10 feet of concrete liner. Removed all temporary concrete forms from the shaft. Cleaned spilled concrete. Installed flexible line between Aldrich (piston) clear water pump and pump discharge line to absorb pulsations.
29	2	115		Lowered all new concrete forming equipment into shaft.
30	2	115		Blocked in 20 feet of concrete forms. Ready for concrete. Dewatered shaft.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

Time usage during the one-month reporting period

(Calculated from information supplied by Battelle at
the end of the project specifically for this report.)

	<u>Hours</u>
Availability to bore	152.5
Maintenance	263.5
Total Project Time	<u>416.0</u>

Actual boring	14
Pour concrete liner	65

Accomplishments

	<u>Feet</u>
Total shaft bored	6
Total concrete liner poured	10

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1 0	115			Sunday, no scheduled work.
2 0	115			Miners holiday, no scheduled work.
3 2	115	20		Dewatered shaft. Cut holes in BSB top deck to divert spilled concrete into hoppers. Poured 20 feet of concrete liner. Cleaned concrete spills.
4 2	115			All removable scrapers in the cutterhead were removed, trimmed 3/8 of an inch then replaced. This was necessary to compensate for cutter wear and to minimize contact between the scrapers and solid rock. Installed rubber flaps inside the hoppers in contact with the back of the doors to minimize muck spillage. Washed inner tower. Cleaned spilled muck from the BSB. Added one drum of FR hydraulic fluid.
5 2	116			Cleaned grout from hoppers and freed hopper doors. Replaced No. 1 bucket elevator reversing valve. Freed No. 1 bucket elevator actuating valve that had been sticking. Mucked out chairs in west skip tube so that the skip would be in the designed position to load muck. Replaced No. 2 flight conveyor chain that walked off the sprockets. Repaired No. 2 flight conveyor chain tensioner. Installed larger fuses on the guide rope tension winches to minimize BSB power shutdowns. Bored 1 foot.

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
6	2	116		Freed both plugged Moyno dewatering pumps. Removed both flight conveyor chains and idler sprocket assemblies. Dried connections on three cutterhead drive motors. Cleaned spilled muck from BSB. Dewatered shaft.
7	2	116		Saturday, scheduled maintenance shift. Rebuilt idler sprocket assemblies. Installed new No. 2 flight conveyor chain. Trimmed paddles on No. 2 flight conveyor chain because they did not fit drive housing assembly. Repaired mancage guide pipe on galloway. Cleaned BSB.
8	0	116		Sunday, no scheduled work.
9	2	116		Considerable water had accumulated in the bottom of the shaft because of the weekend rains. Dewatering pumps were plugged with muck. Capacity of the IR, air driven whirly pump was barely adequate to pump out the water inflow. Cleaned and made the Moyno pumps operational. Dewatered shaft. Installed extensions on the surface skip discharge chutes to reduce amount of muck falling back into the shaft. Cleaned BSB.
10	2	116		Burned clearances around No. 2 flight conveyor drive sprocket to eliminate binding of the paddles. Checked all lines inside inner tower.

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
11	2	117		Started installing new No. 1 flight conveyor chain. Replaced seals in air dump valve on surface air compressor. Cleaned BSB. Worked on gravel road leading into site. Completed installation of No. 1 flight conveyor chain and shimmed clearances. Replaced worn bucket elevator buckets. Dried connections on cutterhead drive motors and various other electrical switches. Retrofitted 5-inch surface concrete hopper discharges with 6-inch lines. Repaired muck haul road from surface muck discharge pad to No. 4 pond location. Bored 1 foot.
12	2	117		Replaced Sunstrand No. 2 flight conveyor pump. Trimmed wear guides that were hanging up both flight conveyors. Dried connections on cutterhead drive motors. Installed new starter on mancage rope tensioning winch. Lost 1½ hours because severe lightning storm necessitated removing all personnel from shaft. Heavy rains washed out the site road in three places.
13	0	117		Good Friday, no scheduled work.
14	0	117		Saturday, no scheduled work.
15	0	117		Easter, no scheduled work.

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
16	2	118		Dewatered shaft. Dried connections to cutterhead drive motors. Replaced leaking rotary air union on BSB because air clutches were losing pressure. Repaired damaged site road. Attempted to get the skips back in sequence after the hopper solenoids malfunctioned. Both flight conveyors were continually jamming. No. 2 flight conveyor jammed more than No. 1.
17	2	119		Capped unused hydraulic hoses that originally were used to actuate the hydraulic bucket elevator chain tensioners to increase No. 2 bucket elevator rpm. Adjusted reversing mechanism of both flight conveyors. Reduced the penetration rate because No. 2 flight conveyor continually hung up under load. Removed hold down support. Bored 1 foot.
18	2	119		Retrofitted old design No. 2 flight conveyor chain hold down bracket with a new rail design. Added a new lower bracket for the No. 2 flight conveyor mechanical chain tensioner. Replaced cutters No. 33, 34 and 43. Cleaned spilled muck from BSB.
19	2	125		Tightened bucket elevator chains. Replaced No. 1 flight conveyor chain that had come loose and walked off the idler sprocket. Started retensioning both flight conveyor chains every hour to preclude similar occurrences.

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
20	2	130		Started retrofitting 5-inch galloway concrete hopper discharges with 6-inch lines. Bored 6 feet. Freed hung bucket elevator. Replaced No. 2 flight conveyor chain that had walked off the idler sprocket and jammed in the drive. Shut down for 5 hours. Changed 36-inch surface exhaust fan. Completed modifying galloway concrete hoppers. Bored 5 feet.
21	2	134		Bored 4 feet to complete 20-foot boring cycle. Tightened bucket elevator and flight conveyor chains every hour. Removed No. 1 flight conveyor assembly and started modifications duplicating those recently made to No. 2. Modified discharge of concrete bucket used for topping concrete pour.
22	0	134		Sunday, no scheduled work.
23	3	134		Project went on three shifts per day. Extended all service, ventilation and slicklines. Continued modifications on No. 1 flight conveyor assembly. Lowered and blocked in all concrete rings and 10 feet of concrete forms.
24	3	134	20	Poured 10 feet of concrete liner. Lowered remaining 10 feet of forms and completed the 20-foot concrete pour.

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
25	3	143		Continued modifications to No. 1 flight conveyor assembly. Cleaned concrete spills. Freed Moyno dewatering pumps. Tightened both flight conveyor and bucket elevator chains twice. Located and repaired hydraulic leak in the east torque cylinders connection. Added 2 drums FR hydraulic fluid. Bored 9 feet.
26	3	144		Bored 1 foot. The propel pressure rose from the normal 800 psi to 2,000 psi indicating a problem in the cutterhead. Freed Moyno dewatering pumps and cyclones. Dewatered shaft and gaged cutters. Replaced cutters No. 6, 8, 32, 44, 45, 46 and 47. Changed Joy 36-inch surface exhaust fan. Reinforced area around the galloway north guide rollers and repaired damage to structure. Cleaned the clean water tank (cyclone discharge).
27	3	144		Had 2 power outages lasting a total of 1½ hours. Stopped boring because cutterhead drive motor clutches did not have enough air pressure. The problem was a dirty air filter. Determined that the rotary air seal in cutterhead drive motors No. 2 and 6 were leaking. Repaired No. 2 but had to declutch No. 6 because there were insufficient parts in warehouse to repair No. 6.

PROJECT LOG BOOK

April, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Increased flight conveyor speed from 33 to 45 rpm.
				Measured distances of belly pans and scrapers to the face.
				Repaired honeycombed concrete liner.
28	3	144		When attempting to bore, the east hopper door did not close to release the skip and threw the hoisting system out of sequence. Electricians bypassed the automatic controls so that the system could be actuated manually. The east hopper door stuck again and signalled the east skip guide tensioning winch to pay out the guide rope. The winch unwound, making a beehive of the rope. To rewind required inspecting and winding the rope on a reel, then spooling it onto the winch drum. The entire day was spent evaluating the problem, assembling all the necessary gear and winding the rope on the reel.
29	0	144		Sunday, no scheduled work.
30	3	145		Spooled 4200 feet of 1½" locked coil rope from the reel to the winch drum.
				Replaced rotary air seals in cutterhead drive motors No. 5 and 6.
				Installed new limit switch on east skip guide rope tension beam.
				Bored 1 foot.
				<u>Time usage during the one-month reporting period</u>
				(Calculated from information supplied by Battelle at the end of the project specifically for this report)
				Availability to bore 172.5
				Maintenance 236.5
				Total Project Time 409.0
				Actual boring 42.5
				Pour concrete liner 72.0
				<u>Accomplishments</u>
				Total shaft bored 30
				Total concrete liner poured 20

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	3	153		Cleaned spilled muck from transfer deck and shaft cover doors. Added two drums of FR hydraulic fluid. Installed guard railing on the south side of the subcollar. Located and repaired hydraulic leak on east torque cylinder connections. Tightened both flight conveyors and bucket elevators every two hours of boring. Increased bucket elevator pressure to 3000 psi and flight conveyor pressure to 2500 psi. Bored eight feet.
2	3	156	10	Bored three feet to complete 20-foot boring cycle. Lowered and blocked in all rings and 10 feet of forms. Washed cutterhead, dewatered shaft and gaged cutters. Poured 10 feet of concrete liner.
3	3	156	10	Completed pouring 20 feet of concrete liner. Cleaned spilled concrete.
4	3	156		Freed Moyno dewatering pumps. Used Gorman Rupp diaphragm pump during interim to dewater shaft. Replaced cutters No. 17, 27, 28, 29, 30, 31, 36, 37, 38 and 39. Rerouted shaft dewatering discharge line so that it empties into No. 1 settling pond. Installed access door and ladder on the southwest corner of subcollar.

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
5	3	156		Cleaned inner tower to gain access to cutters. Dewatered shaft. Replaced cutters No. 5-7, 15, 18, 21, 22, 23, 24, 26, 40, 41, 42 and 43. Cleaned propel cylinder wells.
6	0	156		Sunday, no scheduled work.
7	3	156		Tightened both bucket elevator and flight conveyor chains. Replaced No. 1 bucket elevator idler sprocket. Replaced cutters No. 14, 25 and 48. Located and repaired a connection leak in a propel cylinder. Washed out accumulated muck between inner and outer towers. Installed muck shield over cutter in inner tower. Changed eight buckets on both bucket elevators. Added two drums FR hydraulic fluid. Changed hydraulic oil filter and housing on Sunstrand No. 2 flight conveyor pump. Repaired west skip door.
8	3	159		Replaced air cylinder on west skip collar door. Freed west skip that wedged in the skip tube. No. 2 flight conveyor chain walked off the idler sprocket. Replaced the newly retrofitted chain hold down rail with Astralloy material. Cleaned both skip tubes. Dewatered shaft.

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
9	3	160		Relocated No. 2 flight conveyor drive motor assembly, removed one link and installed chain. Trimmed paddles to give clearances. Performed scheduled maintenance. Bored one foot.
10	3	169		Burned 3/8-inch off No. 1 flight conveyor paddles because they were hitting the bucket elevator buckets. Bored nine feet. Tightened chains on both the flight conveyors and bucket elevators three times. Drilled drain holes through concrete to bleed water from behind shaft liner. Extended service lines. Located and repaired hydraulic leak on propel cylinder connection. Welded pour doors shut on the bottom 10 foot section of concrete forms. Oiled hoist ropes and greased sheaves.
11	3	171		Removed one link from No. 1 flight conveyor chain. Cleaned out No. 2 cyclone. Experienced considerable electrical problems because of water shorting and corroding the connections. Dried connections, replaced cutterhead No. 4 drive motor pothead and No. 6 drive motor starter. Bored two feet.
12	3	171		Spent one shift attempting to determine cause for power delay. Checked all boxes and connections. Repaired stuck cutterhead starter circuit relay. Cleaned and greased sticking west carousel door.

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
13	0	171		Sunday, no scheduled work.
14	3	176		Having electrical problems with the carousel and hopper doors. Both carousel doors close causing the muck to overflow between the towers and into the main bearing seal. Both hopper doors close and electrically shutdown the BSB. Bored five feet intermittently to complete 20-foot boring cycle. Checked and serviced BSB for two hours. Cleaned both skip tubes. Freed skip doors when in scrolls on surface.
15	3	176	10	Installed 30-inch and 36-inch ventilation lines. Lowered and blocked all rings and 10 feet of concrete forms. Poured 10 feet of concrete liner. Unable to get Moyno dewatering pumps operative. Used Gorman Rupp diaphragm pump. Worked on carousel and hopper doors.
16	3	176	10	Lowered and blocked remaining 10 feet of forms. Poured remainder of the 20-foot section of concrete. Cleaned spilled concrete. Dried potheads in two cutterhead drive motors that were shutting down the BSB. Bypassed solenoid on west hopper door. Started boring but No. 1 flight conveyor chain broke.
17	3	176		Dewatered shaft. Removed No. 1 flight conveyor assembly in preparation to install retrofit.

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Modified retrofit to fit the cutterhead.
18	3	176		Continued to cut and fit No. 1 flight conveyor retrofit into cutterhead. Attempted to make the Moyno dewatering pumps operational. Cleaned BSB.
19	3	176		Continued to cut and fit No. 1 flight conveyor retrofit into cutterhead. Installed No. 2 flight conveyor belly pan.
20	0	176		Sunday, no scheduled work.
21	3	176		Cutterhead was preloaded at the end of the shift Saturday. The stress sheared the No. 1 flight conveyor alignment bolts, bent both belly pans and cracked all the welds made during the retrofit. Experienced delays in dewatering the shaft because of power failures. Replaced the bolts, straightened the bent belly pans with hydraulic jacks, wedges and heat and started rewelding the broken welds. Started modifying the hoppers to reduce muck spillage.
22	3	176		Continued straightening, cutting and fitting No. 1 flight conveyor assembly into cutterhead. Grouted behind concrete lining at 68 and 88 foot depths. Continued modifying hoppers. Cleaned BSB.
23	3	176		Continued welding No. 1 flight conveyor retrofit into cutterhead and modifying hoppers. Installed door in galloway.

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
24	3	176		Constructed enclosure for the skip hoist operator. Made weekly inspection of all hoisting components. Continued cutting and fitting the No. 1 flight conveyor into the cutterhead and modifying hoppers. Grouted water leaks behind concrete lining. Had two-hour power outage originating at the power substation. Used emergency generator. Cleaned BSB and galloway.
25	3	176		Continued cutting and fitting the No. 1 flight conveyor into the cutterhead and modifying hoppers.
26	0	176		Saturday, no scheduled work.
27	0	176		Sunday, no scheduled work.
28	0	176		Memorial Day, no scheduled work.
29	3	176		Started assembling No. 2 flight conveyor retrofit on installed belly pan. Completed modifying hoppers. Loaded and shipped 32 drums of mine muck to Robbins in Seattle.
30	3	176		Completed and tested both flight conveyor retrofits. No. 1 flight conveyor was running rough and hanging up. Reworked the rail chain hold down and trimmed the paddles by 3/4-inch. Problem still not solved. Repaired the broken shaft in the Dynex propel pump. Dewatered shaft and, on the surface, mucked out the north discharge ditch. Replaced solenoid on the mancage electric brakes.

PROJECT LOG BOOK

May, 1979

DAILY ACTIVITIES

31 3 177

Trimmed 3/4-inch from the back of the No. 1 flight conveyor paddles.

Bored one foot sporadically because the carousel doors would not operate properly and the No. 1 flight conveyor was hanging up.

Adjusted man hoist brakes.

Installed belting covers over all electrical connections on the machinery deck.

Time usage during the one-month reporting period

(Calculated from information supplied by Battelle at the end of the project specifically for this report.)

	Hours
Availability to bore	138
Maintenance	362
Total Project Time	500
Actual boring	54.5
Pour concrete liner	76.0
<u>Accomplishments</u>	<u>Feet</u>
Total shaft bored	32
Total concrete liner poured	40

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	3	178		Repaired computer. Bored one foot sporadically because No. 1 flight conveyor idler sprocket was filling with muck and had to be chiseled out frequently. Adding more water helped, but did not alleviate the problem. Changed the four-way hydraulic spool valve on the carousel to stop the west carousel door from remaining closed and causing the carousel to overflow between the towers and into the main bearing seal. Continually had to free the east hopper door. Moffit of Robbins arrived on site to assist in eliminating problems with retrofit of the No. 1 flight conveyor. Whalen of MSHA inspected the site.
2	3	180		Identified and corrected the electrical problem that caused the methane sensors to shut down the BSB. Bored two feet sporadically with a continuation of the same problems experienced the previous day, that is, the No. 1 flight conveyor sprocket was filling with muck and had to be cleaned frequently. The west carousel door remained closed and east hopper door had a tendency to stay open. Replaced the recently changed four-way hydraulic spool valve with the original valve. Enlarged the undersized slots on the No. 1 flight conveyor mechanical chain tensioner. Added three drums of FR hydraulic fluid. The FR hydraulic fluid is replacement for that lost through leaks, hydraulic repairs and broken hoses. The lost fluid is pumped to surface with the boring water and ends up in the settling ponds.
3	0			Sunday, no scheduled work.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE SHIFTS WORKED DEPTH, FEET CONCRETE POURED (FT.)				
4	3	183		Straightened listing galloway because mancage was rubbing guide wheels. Changed two broken guide wheels on the galloway. Bored two feet with continued muck buildup problems on No. 1 flight conveyor sprocket. Replaced cutters No. 20, 33, 34 and 35. Installed surface Joy 30-inch exhaust fan.
5	3	185		Bored two feet with continued muck buildup problems. Replaced plugged filters on No. 2 hydraulic tank and No. 1 flight conveyor pump. Located and replaced bad relay in the ground check pilot that shut the BSB down for 3½ hours. Temporarily repaired the pilot pressure reducing valve for the west carousel door. Robbins will air freight new valves from Seattle. Changed inoperative hydraulic cylinder on the west carousel door. Reworked east hopper door. Dried potheads that were intermittently shutting down the BSB.
6	3	185		Changed inoperative four-way electrical solenoid valve on the bucket elevator. The change required one shift. Replaced worn No. 2 hardened flight conveyor chain after 118 hours of accumulated usage. Burned 2 3/4 inches of steel from the inside of the paddles. Changed radius on No. 2 flight conveyor frame and installed new hold down chain rail. Added broken rope switch to the skip hoisting system. Modified the locally built replaceable scrapers that were beveled on the wrong side.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	3			Bored one foot and still had the same problems with No. 1 flight conveyor idler sprocket filling with muck. Burned out and replaced a section of the No. 2 flight conveyor belly pan that had bent and could not be straightened. Welded $\frac{1}{4}$-inch shims on the locally built scrapers to increase the thickness from $\frac{3}{4}$-inch to the design size of one inch. Installed locally made scrapers in the cutterhead.
8	3	187		Bored slowly to wear the new scrapers into the contours of the face. Installed a muck scraper on the No. 1 flight conveyor idler sprocket to prevent muck from building up. Replaced worn chain hold down rail on the No. 1 flight conveyor. Removed the unnecessary hydraulic flow control valves on the carousel doors. Changed the hydraulic plumbing on the hopper doors so that it complied with the drawings. Removed and rerolled the radius on No. 2 flight conveyor frame. Richards and Moffat of Robbins and Braswell of DOE arrived on the site today.
9	3	191		Bored four feet with No. 1 flight conveyor idler sprocket still filling with muck. Had to stop when both flight conveyors became plugged. Cleaned both flight conveyors (three hours). Shortened both flight conveyor chains by one-half link. Replaced surface laser gun. Shimmed west carousel gate bracket.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10 0	191			Sunday, no scheduled work.
11 3	194			Fabricated and installed new mechanical flight conveyor chain adjustments which will have more takeup travel. Replaced filter capacitor in panel that sends drive motor amperage readings to surface computer. Cleaned top of main bearing seal located between the inner and outer towers. Freed No. 1 flight conveyor chain that broke and lodged under cutterhead. Chain had 20 hours run. Installed new No. 1 flight conveyor chain.
12 3	196			Bored two feet to complete 20-foot boring cycle. Extended service lines. Lowered and blocked in all concrete rings.
13 3	196	20		Lowered and blocked in 20 feet of forms in two stages. Poured 20 feet of concrete liner. Cleaned concrete spills. Installed one-half link on No. 1 bucket elevator.
14 3	196			Removed one link from No. 1 flight conveyor chain. Mucked out clear water tank and dewatered shaft. Cleaned accumulated spilled muck from the subcollar deck and steel to prevent the muck from falling on the miners. Started modifying the skips.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
15	3	196		Modifying No. 1 flight conveyor retrofit as instructed by Moffat and Richards of Robbins and modifying skips per drawings furnished by Lake Shore. Checked hydraulic lines to bucket elevators.
16	3	196		Continued modification of No. 1 flight conveyor and skips. Changed bucket elevator drives from original two Vickers pumps to one Sunstrand dewatering pump. Added flow control valves to the bucket elevators circuitry to control rpm.
17	0	196		Sunday, no scheduled work.
18	3	196		Completed modification of west skip. Changed bucket elevator drives back to original two Vickers pumps. Installed water sprays at the bucket elevator discharge to help clean buckets. Started reassembling original No. 2 flight conveyor assembly with intent to postpone modifications to a more opportune time.
19	3	196		Continued modification of east skip and No. 2 flight conveyor assembly Cleaned site.
20	3	196		Completed both No. 2 flight conveyor assembly and east skip modifications. Drained lubricating oil from tank, main bearing and bull gear cavity. Changed both tank and pressure lubricating filters. Although the flags did not indicate so, the filters were plugged with dirt. Cleaned and oiled all hoist ropes.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Wiped the lubrication oil tank clean.
21	3	196		Added seven drums of lubrication oil and two drums of FR hydraulic fluid. Hosted 40 visitors from the Rapid Excavation and Tunneling Conference held in Atlanta. Bored for visitors approximately 30 minutes in a coal seam without any advance. Jammed bucket elevators. Built air-water spray.
22	3	197		Replaced Dennison gripper pump. Installed air-water spray in flight conveyor hoppers to keep buckets and paddles clean. Air pressure exceeded water pressure so air backed into the line. Extended service lines. Bored one foot.
23	3	200		Replaced hydraulic hose to No. 1 flight conveyor twice. Added four drums of FR hydraulic fluid. Bored dry for two feet in a coal seam. Started adding water because the coal dust covered the surface plant and was judged to be explosive. Intent was to wet bore through the coal seam and then try dry boring again. Cleaned jammed bucket elevators several times during the remaining foot of wet boring.
24	0	200		Sunday, no scheduled work.
25	3	202		Added one drum of FR hydraulic fluid. Greased skip sides and rollers to prevent hanging up in the headframe scrolls.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
26	3	209		Slowed bucket elevators from 55 to 27 rpm without any change in performance. Replaced one surface laser gun. Patched honeycombed concrete liner. Bored two feet while attempting to convert from wet to dry boring. Lost hydraulic pressure to the southeast propel cylinders. Spent 1½ shifts attempting to identify and correct problem. Bored seven feet with both the flight conveyors and bucket elevators continually jamming. Could not dry the face to start dry boring. Attempted to free the tight skips inside the headframe scrolls. These have been tight since the modifications were made.
27	3	217		Bored eight feet wet to complete 20-foot boring cycle. Lowered and blocked in all concrete rings. Advanced service and ventilation lines. Damaged grids on skip hoist because hoistman was braking while under power. Hoist still operational. Ordered new grids. Started constructing new bridge over north drainage ditch.
28	3	217	20	Lowered and blocked in concrete forms in two stages. Poured 20 feet of concrete liner. Cleaned concrete spills. Washed cutterhead, dewatered shaft and gaged cutters. Whalen of MSHA inspected site.

PROJECT LOG BOOK

June, 1979

DAILY ACTIVITIES

PROJECT LOG BOOK			
June, 1979			
DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)
DAILY ACTIVITIES			
29	3	222	
Cleaned check valve in the east bank of propel cylinders.			
Bypassed inoperative automatic ball float on west hopper that controls the door.			
Replaced the Denison gripper pump to increase gripper pressure. BSB continued to slip.			
Bored five feet.			
30	3	222	
Henceforth, one shift will work Saturdays. It will be devoted to scheduled maintenance. Consequently, the crews will work six days per week every third week.			
Cleaned inner tower in preparation for gaging the cutters.			
Remodeled laser target brackets.			
Time usage during the one-month reporting period			
(Calculated from information supplied by Battelle at the end of the project specifically for this report.)			
			Hours
Availability to bore			209.7
Maintenance			398.3
Total Project Time			608.0
Actual boring			76.7
Pour concrete liner			67
Accomplishments			
			Feet
Total shaft bored			45
Total concrete liner poured			40

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PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	3	222		Sunday, no scheduled work.
2	3	222		Replaced multiple center cutters No. 5-7, 6-8, 9-11 and 10-12. No. 1-3 and 2-4 had only 1/16-inch wear. Cleaned concrete and muck spills on BSB. Completed modifying laser targets. Deburred flanges and removed dings from ventilation pipe flanges to be installed.
3	3	223		Gaged cutters. Replaced damaged galloway south guide wheel. Bored one foot. Changed solenoids on west hopper door and No. 2 flight conveyor. Drained 20 gallons of water from lubrication tank. Added two drums of FR hydraulic fluid. Started installing 1-inch air line from surface to BSB.
4	0	223		July 4 holiday, no scheduled work.
5	3	228		Dewatered shaft. Mucked out east and west skip tubes. Checked pilot control valves and laser guidance system. Identified and corrected cause of methane monitor shutting down BSB. Galloway misalignment caused skip to hit tube and jar monitor. Greased skip guides on surface to minimize hangups in headframe. Bored five feet at less than acceptable rate. Worn cutters was the suspected cause.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
6	3	228		Gaged cutters. Replaced cutters No. 19, 36, 41 and 43. Replaced cutters No. 17, 18, 21, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33, 37, 38, 39, 40, 42, 44, 45 and 46. Modified cutters so that pipe plugs were flush with the bearing housing. Changed four helicoils that anchor the cutter bolts to the cutterhead. Constructed toplander shack.
7	1	228		Scheduled maintenance shift. Changed pressure relief valve in lubrication system to dump at a higher pressure of 700 psi. Replaced cutters No. 30 and 50. Modified concrete forms to open more freely. Cleaned spilled muck from headframe structures. Dewatered shaft. Relocated air and water piping on BSB.
8	0	228		Sunday, no scheduled work.
9	3	232		Replaced cutters No. 26 and 49. Repaired switches on east skip shaft cover, west carousel and west hopper doors. Relocated west hopper door hydraulic cylinder that caused the door to jam. Burned off and replaced damaged portion of No. 2 flight conveyor idler sprocket guide plate. Bored four feet.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10	3	235		Bored three feet to complete 20-foot boring cycle. Extended service and ventilation lines. Replaced hydraulic balance valve on bucket elevator. Lowered and blocked in all the concrete rings and 10 feet of forms. Met with union regarding demands to put two hoistmen on each hoist.
11	3	235	20	Cleaned air strainer. Conducted tour for MSHA, BOM and US Steel officials. Poured 20 feet of concrete liner in two stages. Concrete had too much aggregate (low lubricity) and too little slump. It hung up several times in the slickline. Cleaned concrete spills.
12	3	235		Determined that No. 2 flight conveyor was completely worn out and decided to start modification of retrofit. Removed No. 2 flight conveyor assembly. Cleaned concrete spills from the galloway.
13	3	235		Installing No. 2 flight conveyor modifications. Inspected all hoisting equipment and greased sheaves.
14	1	235		Installing No. 2 flight conveyor modifications. Stringing permanent electrical cable to hoist house.
15	0	235		Sunday, no scheduled work.
16	3	235		Installing No. 2 flight conveyor modifications. Straightened and modified concrete forms.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
17	3	240		Chipped out flattened north side of shaft to conform with rest of shaft. Repaired concrete handling equipment damaged during the last pour. Refaced flanges on ventilation pipe. Completed installing No. 2 flight conveyor modifications. Removed boulder under No. 1 flight conveyor idler sprocket muck scraper and checked sprocket for damage. Cleaned air filter that caused the air clutches to shut down BSB. Repaired methane monitor that kept shutting BSB down. Bypassed malfunctioning west full hopper probe. Changed broken hydraulic hose. Freed east skip out of scrolls in headframe. Bored five feet.
18	3	247		Replaced worn No. 1 flight conveyor chain, damaged idler sprocket bearing and worn chain hold down rail. Fabricated and changed damaged chain tensioner. Cleaned galloway. Bored seven feet. Subcontractor started cleaning and trucking solids from No. 1 settling pond to No. 4 storage pond.
19	3	250		Replaced Sunstrand No. 2 flight conveyor motor that leaked and filled the gear box with FR hydraulic fluid. Relocated laser target bracket on the cutterhead so that when making steering adjustments the rear shield will not hit the target.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Installed lower muck guard on No. 2 flight conveyor. Bored three feet. Subcontractor still cleaning No. 1 settling pond.
20	3	255		Bored five feet to complete 20-foot boring cycle. Replaced Denison gripper pump. Installed rope ladder between galloway and BSB. Extended ventilation pipes. Lowered but could not block in the concrete rings because of the inability to align the laser beams on the ring targets. Whalen of MSHA inspected the site. US Steel warned Cementation that contaminated water from No. 4 solid storage pond was draining into main stream.
21	1	255		Realigned west laser target. Added two drums of FR hydraulic fluid. Repaired bridge damaged by subcontractor's backhoe.
22	0	255		Sunday, no scheduled work.
23	3	255	20	Lowered and blocked in the remainder of concrete forms. Poured 20-foot concrete liner in two stages. Cleaned spilled concrete on galloway and BSB.
24	3	255		Completed concrete cleanup. Cleaned clear water tank and dewatered shaft. Bypassed methane monitor that was shutting off power on BSB.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
25	3	259		Checked No. 1 flight conveyor idler sprocket and determined that the bearing was worn and shaft damaged. New shaft was machined in Birmingham. Meeting was held with union to determine overtime policies. Replaced Dennison gripper pump. Installed No. 1 flight conveyor idler sprocket assembly. Introduced dewatering pump and cyclone to recirculate water from the east hopper to the face. Extended service lines. Straightened doors on the inner towers that became bent when mechanics left the doors open while using the inching motor. Bored four feet.
26	3	260		Bypassed Denison gripper with the Sunstrand dewatering pump because the gripper ring did not have enough hydraulic pressure and allowed the BSB to slip. Replaced Denison gripper pump. Installed remote control air valves to operate the galloway concrete form winches from the BSB. Removed one-half link from each of the bucket elevators. Cleaned spilled muck from shaft cover doors. Bored one foot.
27	3	260		Replaced 20 broken buckets on both bucket elevators. Retrofitted Sunstrand No. 2 flight conveyor with Sunstrand dewatering pump. Interface was not compatible and pump would not work.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Changed all the hydraulic filters. Several had collapsed but the flags indicated that they were clean and operational.
				Concluded that the last drums of FR fluid added were not compatible with that already in the system.
				Drained the hydraulic system and added four drums of the original FR fluid.
28	1	260		Ran all the hydraulics for four hours to purge the incompatible fluid then drained the system.
				Installed new rope socket on mancage.
29	0	260		Sunday, no scheduled work.
30	3	260		Installed Sunstrand No. 2 flight conveyor pump.
				Replaced Denison gripper, Sunstrand dewatering and Vickers double pump that drives a water pump and the lubrication circuit.
				Patched honeycombed concrete liner.
				Checked and serviced all hoisting equipment.
				Greased sheaves and oiled ropes.
				Added five drums of FR hydraulic fluid.
31	3	267		Added four drums of FR hydraulic fluid.
				Cleaned up all trash generated when changing pumps.
				Tightened bucket elevator and flight conveyor chains.
				Resequenced skips with the hoppers several times during boring.
				Replaced Rexroth east bank, propel cylinder flow control valve.
				Bored seven feet.

PROJECT LOG BOOK

July, 1979

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(F.T.)

Time usage during the one-month reporting period

Hours

Availability to bore	126.0
Maintenance	362.0
Total Project Time	488.0

Actual boring	54.0

Pour concrete liner	51.5

Accomplishments Feet

Total shaft bored	45

Total concrete liner poured	40

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	3	276		Tightened both flight conveyor chains. Replaced pressure control valve on Denison gripper pump. Experienced several delays because of power losses to BSB and skips getting out of sequence with the hoppers. Removed broken scrapers from No. 1 flight conveyor pickup. Bored nine feet to complete 20-foot boring cycle.
2	3	276	20	Extended ventilation lines. Lowered and blocked all concrete rings and 10 feet of concrete form. Poured 10 feet of concrete liner. Lowered and blocked remaining 10 feet of form. Completed pouring remaining 20 feet of liner. Cleaned concrete spills.
3	3	276		Cleaned all concrete distribution equipment. Removed No. 1 flight conveyor assembly and burned out worn belly pan. Started fabricating new pan. Washed cutterhead and gaged cutters. Checked slicklines with plumb bobs hung to bottom of shaft.
4	2	276		Saturday, scheduled maintenance shift. Hoist operators did not report for work and miners refused to ride mancage operated by substitute operator. All work was on surface. Day shift worked four hours and night shift five hours. Rewound skip hoist ropes on drums.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
5 0	276			Sunday, no scheduled work.
6 0	276			Miners did not report for work in protest to the rough condition of the site gravel road.
7 3	276			Indexed and tacked the No. 1 flight conveyor belly pan on the bottom of the cutterhead. Replaced hydraulic cylinder rod seal on west hopper door. Cleaned spilled concrete and muck from BSB. Replaced cutter No. 34 Repaired road to site.
8 3	276			Welded No. 1 flight conveyor belly pan to cutterhead. Installed No. 1 flight conveyor assembly. Replaced cutters No. 16, 34, 35, 48, 55 and 56. Changed Helicoil on No. 43 cutter. Made hold down wedges and replaced three broken scrapers in cutterhead. Searched but did not find pieces. Tried unsuccessfully to bore dry. Had to wash and unplug both flight conveyors.
9 3	279			Tightened all the cutters after discovering perimeter (gage) cutters were loose. Started boring and lost four scrapers. Searched and found three of them. Replaced worn scrapers No. 4 and 5. Inspected all hoisting equipment and sheaves. Repaired probes on both hoppers.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10	3	279		Replaced O-ring on the Denison gripper pump. Bored three feet. Washed cutterhead and checked all cutters. Tightened 27 cutters that had become loose in three feet of boring. Replaced scrapers No. 3-4, 5-6 and 9. Changed No. 2 flight conveyor chain tensioner. Repaired east skip door.
11	1	279		Saturday, scheduled maintenance shift. Inspected and adjusted brake on man hoist. Repaired site road.
12	0	279		Sunday, no scheduled work.
13	3	281		Bored dry for two feet. Area around surface exhaust fan covered with dust. Cleaned hopper door hinges that were full of dry muck. Attempted to get hopper doors in sequence with skips during boring. Replaced seal in Denison gripper pump. Adjusted and modified bucket elevator water sprays in inner tower. Added two drums of FR hydraulic fluid. Chipped concrete and made operational modifications to forms.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
14	3	285		Jacked and welded No. 2 flight conveyor frame back into place and rewelded chain hold down rail to frame. Continued to have problems synchronizing hopper doors with skips. Installed water spray on surface exhaust fan to control dust. Replaced magnetic switch on east hopper door. Bored dry for four feet. Whalen of MSHA inspected site.
15	3	291		Ran BSB for two hours attempting to dry muck. Bored mixture of wet and dry muck for six feet. Replaced broken water swivel on top of BSB. Cleaned lubrication system plumbing and valving to increase pressure. Cleaned spilled muck from BSB.
16	3	293		Attempted to bore dry but the water sprays used to control dust and clean the buckets and hoppers made the muck sticky. The consequence is that the doors would not close after the skips were emptied. Welded No. 1 flight conveyor main frame side piece that came loose. Installed 90° elbow on the surface exhaust fan discharge. Replaced hydraulic hose on No. 2 flight conveyor. Adjusted hoist safeties. Had meeting with Union to discuss seven grievances.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
17	3	293		Replaced same hydraulic hose on No. 2 flight conveyor. Added two drums of FR hydraulic fluid. Replaced No. 2 flight conveyor chain on sprockets. Drive sprocket slipped on shaft and chain was badly worn. Mucked out No. 2 flight conveyor compartment. Removed No. 2 flight conveyor gearbox that had lost all its seals and oil.
18	1	293		Pulled original 300 feet of BSB power cable out of the shaft and replaced it with length sufficient to complete the shaft.
19	0	293		Sunday, no scheduled work.
20	3	293		Plumbed slicklines. Installed phone line from surface to Galloway to establish communication. Inspected all hoisting equipment, sheaves and wire rope. Moved galloway to 40-foot depth and started grouting behind concrete liner to shut off flow of water.
21	3	293		Oiled all ropes and guides. Continued grouting.
22	3	293		Installed welding leads from surface to the galloway. Continued grouting.
23	3	293		Completed grouting. Patched honeycombed concrete liner. Connected power and communications from galloway to BSB. Dewatered shaft.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
24	3	293		Installed No. 2 flight conveyor. Sunstrand pump would not deliver pressure. Changed filters. Washed cutterhead and gaged cutters.
25	1	293		Saturday, scheduled maintenance. Changed cutters No. 20, 33, 40, 47, 48 and 51. Installed hinges on cleanout doors under skip tubes. Repaired concrete forms.
26	0	293		Sunday, no scheduled work.
27	3	293		Changed cutters No. 13, 21, 30, 32, 36, 47, 38, 39 and 52. Repaired solenoid valve on west hopper door. Replaced Vickers lubricating pump that would not produce enough volume. Patched honeycombed concrete liner. Inspected and lubricated hoists and sheaves.
28	3	297		Spent most of one shift attempting to balance lubrication pressure (Vickers hydraulic pump driving Commercial shearing motor driving DeLaval lubrication pumps) with the scavenging (Sunstrand motor driving Moyno pump) systems. Determined that the replacement Vickers lubricating pump was worn. Bypassed the Vickers with the Sunstrand dewatering pump. Cleaned muck buildup on switches that were signalling the hoistman that the open hopper doors were closed. Extended ventilation lines. Bored four feet to complete 20-foot boring cycle. Lowered and blocked in concrete forming rings.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
29	3	297	20	Added forms and poured 20-foot concrete liner in two stages. Cleaned spilled concrete and concrete handling equipment. Replaced Vickers lubricating (driver) and DeLaval (driven) lubrication pumps.
30	3	298		Chipped hardened concrete out of remix pots. Replaced shaft and bearing on No. 2 flight conveyor idler sprocket. Replaced Denison gripper pump that would not hold the required 4,000 psi pressure. Added two drums of FR hydraulic fluid. Washed inner tower. Drained lubricating oil tank and changed filters. Bored one foot.
31	3	298		Washed muck from top of main bearing seal between inner and outer towers. Wiped lubricating oil tank clean and added six drums of oil. Drained hydraulic system. Flushed hydraulic system with five drums of FR hydraulic fluid. Changed all filters in hydraulic system. Added eight drums of FR hydraulic fluid. Removed both bucket elevator idler sprockets for rebuilding.

PROJECT LOG BOOK

August, 1979

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

Time usage during the one-month reporting period

Hours

Availability to bore 65.6
Maintenance 399.4
Total Project Time 465.0

Actual boring 32.6

Pour concrete liner 29.0

Accomplishments

Feet

Total shaft bored 31
Total concrete liner poured 20

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1 0	298			Saturday. Labor Day weekend, no scheduled work.
2 0	298			Sunday, no scheduled work.
3 0	298			Labor Day, no scheduled work.
4 3	298			Replaced leaking lubrication filter and housing. Leak was caused by a stripped assembly bolt. Changed Sunstrand No. 2 flight conveyor pump and pressure relief valve. Repaired pickup side of No. 2 flight conveyor belly pan that had worn thin, bent up and jammed the chain. Cleaned No. 1 flight conveyor pressure valve.
5 3	302			Replaced Sunstrand No. 1 flight conveyor pump. Attempted to bore dry but sticky muck plugged bucket elevator pickups and required that the BSB be shut down and hand mucked. Removed one link from No. 1 flight conveyor. Repaired hydraulic hose in No. 2 flight conveyor system and air swivel. Had two-hour computer readout delay. Bored four feet and deposited dust over all of the surface plant.
6 3	306			Experienced an unusual lubrication problem. The Moyno scavenger pump did not develop sufficient pressure and caused an imbalance in the system by allowing the Delaval pump to evacuate the tank, overflow the cavity and overflow the excess oil through the main bearing seal between the towers. Hand removed sticky muck from the inner tower. Replaced blades in exhaust fans that had been severely worn by the dry, abrasive muck.

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	3	307		Stopped dry boring after a nearby contractor complained about the excessive dust and threatened to contact authorities. Bored dry for four feet and converted to wet boring. Bored one foot intermittently because the Moyno scavenger pump did not have capacity to keep up with the DeLaval pressure pump. It was necessary to periodically disconnect the DeLaval to allow the Moyno pump to fill the reservoir. Detected considerable oil between the towers that was forced through the main bearing seal. Removed the five psi air line that pressurizes the main bearing seal. Replaced cutter No. 47 and bearing on No. 1 flight conveyor idler sprocket. Changed Vickers dual pump that drives the lubrication and dewatering motors.
8	1	307		Saturday, scheduled maintenance work. Extended exhaust ventilation line. Replaced leaking lubrication oil filter. Repaired leaking air swivel on cutterhead No. 2 drive motor clutch. Cleaned ventilation exhaust line at fan intake. Installed new hinge pins on west hopper doors. Lubricated both doors.
9	0	307		Sunday, no scheduled work.
10	3	310		Replaced DeLaval lubrication oil pump. Changed cutters No. 34 and 49. Straightened scraper No. 7.

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
11	3	313		Retrofitted Moyno scavenger pump needle with original Vickers solenoid valve. Repaired hanging east carousel door. Added two drums lubrication oil and changed filters. Bored three feet in attempt to dry face. Replaced cutters No. 32 and 33. Repaired No. 2 flight conveyor twice, initially to weld the sheared chain hold down rails, then later to replace the rails and reinforce the gear box bracket. Repaired honeycombed concrete liner. Dried west hopper probe several times during boring. Bored three feet.
12	3	317		Replaced No. 1 flight conveyor chain. Dried west hopper probe several times. Completed 20-foot boring cycle by operating the probe manually. Stopped BSB several times to manually clean plugged muck from No. 2 flight conveyor. Extended service lines. Changed DeLaval lubrication pump and four-way low pressure lubrication oil valve.
13	3	317		Changed broken galloway guide roller. Lowered and blocked in all concrete forming rings and first 10 feet of form. Ready to pour concrete. Extended 30-inch exhaust ventilation line. Repaired man hoist brake.

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
14	3	317	20	Hurricane Frederick blew several fiberglass panels from hoist house. Poured 20-foot concrete liner in two stages. Cleaned concrete spills. Washed cutterhead, dewatered shaft and gaged cutters. Replaced cutter No. 46 and 57. Had 3½ hours power failure due to a BSB broken breaker and emergency stop button lodged in off position. Changed scraper No. 7. Continued reinforcing No. 2 flight conveyor frame.
15	1	317		Saturday, scheduled maintenance work. Replaced cutters No. 28 and 42. Removed one-half link from No. 2 bucket elevator. Cleaned inner tower.
16	0	317		Sunday, no scheduled work.
17	3	317		Graveyard shift went home early because there was no hoistman. Replaced cutters No. 14, 15, 17, 20, 21, 22, 23, 24, 25, 27, 29, 31, 44 and 45. Dewatered shaft.
18	3	317		Replaced cutters No. 18, 19, 41, 49 and 50. Dewatered shaft. Welded patch in No. 2 flight conveyor belly pan and welded replacement chain hold down rail to main frame. Installed rubber flaps in transition from hoppers to doors.

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
19	3	327		Cleaned concrete forming accessory equipment. Installed new No. 2 flight conveyor chain. Repaired broken No. 2 flight conveyor chain during the 10 feet of boring advance. Removed water in cylinders and repaired galloway air tuggers used to handle concrete forms.
20	3	332		Replaced cutters No. 29, 30, 38 and 39. Rehung 30-inch flexible ventilation exhaust line that had broken loose and fell on BSB. Lost No. 1 scraper and later discovered that it lodged against No. 3 scraper. Changed scrapers No. 5 and 6. Welded No. 2 flight conveyor chain hold down rail that had broken loose and hung the chain. Added three drums of FR hydraulic fluid. Bored five feet.
21	3	337		Replaced Vickers skip loading and Denison gripper pumps. Cleaned surface pump that supplied boring water to BSB. Cleaned Rexroth flow control and pressure relief valves. Bored five feet to complete 20-foot boring cycle.
22	3	337		Saturday, scheduled maintenance shift. Washed cutterhead and replaced No. 36 cutter. Tightened all cutter bolts. Removed one link each from No. 1 and 2 flight conveyor chains.

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Tightened both bucket elevator chains, replaced six buckets and lubricated idler sprocket.
				Checked clutch on cutterhead No. 5 drive motor.
23	0	337		Sunday, no scheduled work.
24	3	337	20	Lowered and blocked all concrete forming rings and 10 feet of forms.
				Poured 20 feet of concrete liner in two stages.
				Cleaned spilled concrete and concrete handling equipment.
				Changed Traybon oiler in lubrication system.
				Whalen of MSHA inspected site.
25	3	349		Removed one-half link from No. 2 bucket elevator chain.
				Cleaned Rexroth west propel cylinders flow control valves.
				Bored 12 feet.
26	3	354		Replaced Dennison gripper pump.
				Cleaned two of the three Rexroth propel cylinder flow control valves.
				Changed inoperative pilot pressure valve.
				Repaired No. 1 flight conveyor chain and replaced chain hold down rail.
				Burned hole in curb ring to chip out the grout that had worked its way through the laser tube and cemented the ring in place.
				Added two drums of FR hydraulic fluid.
				Bored five feet.

PROJECT LOG BOOK

September, 1979

DAILY ACTIVITIES

				PROJECT LOG BOOK	
				September, 1979	
				DAILY ACTIVITIES	
DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)		
27	3	357		Replaced hydraulic hose in inner tower.	
				Added two drums of lost FR hydraulic fluid.	
				Bored three feet to complete 20-foot boring cycle.	
				Extended service lines.	
28	3	357	20	Lowered and blocked in concrete rings and 10 feet of forms.	
				Poured 20 feet of concrete liner in two stages. Concrete did not have enough slump and would not distribute itself.	
				Cleaned concrete spills and concrete handling equipment.	
				Washed cutterhead, dewatered shaft and inspected cutters.	
				Replaced cutters No. 34, 35, 37, 40, 53 and 54.	
29	1	357		Saturday, scheduled maintenance shift.	
				Cleaned concrete and muck from BSB.	
				Changed lubricating oil and filters.	
				Greased BSB.	
				Inspected and greased all hoisting equipment.	
				Installed west laser target on BSB.	
30	0	357		Sunday, no scheduled work.	
				<u>Time usage during the one-month reporting period</u>	
				Hours	
				Availability to bore 197	
				Maintenance 291	
				Total Project Time 488	
				Actual Boring 64	
				Pour concrete liner 63	
				Accomplishments	
				Feet	
				Total shaft bored 59	
				Total concrete liner poured 60	

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	3	357		Changed all lubrication and hydraulic oil filters. Added 6 drums of lubricating and 2 drums of FR hydraulic oil. Inspected and greased all hoist and guide ropes and scrolls. Cleaned concrete spills. Chipped hardened grout from east skip hopper. It was dumped into the hopper when the slick lines were flushed prior to pouring concrete. Replaced west laser target. Sands and Danowski arrived on job site.
2	3	361		Bored 4 feet. Replaced Vickers skip loading pump. Repaired filter leak on other Vickers skip loading pump. Stripped and lowered all concrete rings. Gillespie, Conrad, Sands, Amstutz and Danowski met on the site to discuss project status and future plans.
3	3	371		The existing filter system is unable to keep the lubricating clean and free of sediment. The oil lubricates the main bearing and cutterhead drive motors. If the main bearing fails, the BSB will have to be demobilized, hoisted to surface for repairs and then mobilized. Replaced Vickers skip loading pump. Cleaned propel flow control valves that were causing erratic steering. Replaced Sunstrand No. 1 flight conveyor pump. Replacement did not work so the idle Sunstrand dewatering pump was used temporarily.

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
4	3	375		Cleaned concrete forms. Met with Gillespie, Aubuchon, Rasmussen and Sands to express concern over the contaminated lubrication oil. Cleaned all propel flow control valves. Bored 4 feet. Replaced Denison gripper pump. Replacement did not work. Installed Sunstrand No. 1 flight conveyor pump and used the now idle Sunstrand dewatering pump to power the gripper circuit. Repaired east skip door which was jammed for 1/2 hour. Electrical storm shut down power for 1/2 hour.
5	2	375		Bored 1 foot to complete boring cycle at noontime. Extended service lines and prepared to pour concrete. Cleaned propel flow control valves. Replaced No. 2 flight conveyor chain and Vickers No. 1 bucket elevator pump. Sands returned to Spokane.
6	1	376		Saturday, scheduled maintenance. Replaced Vickers dual lubrication/dewatering pump. Installed new bearing in No. 2 flight conveyor idler sprocket. Removed 1 link from No. 2 bucket elevator chain to compensate for stretch. Changed hydraulic oil return filters.

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	1	376		Changed cutter No. 36. Lowered and blocked in all rings and 10 feet of forms.
8	3	376	20	Poured 20 feet of concrete liner in 10-foot lifts. Cleaned concrete spills. Replaced cutters No. 3, 46, 49. Changed No. 1 flight conveyor chain. Changed hydraulic oil filters.
9	3	376		Replaced Denison gripper and Vickers No. 2 bucket elevator pumps. Changed relief valves on No. 1 bucket elevator and No. 2 flight conveyor pumps. Added 1 drum of FR hydraulic fluid. Repaired honeycombed concrete liner.
10	3	384		Replaced Sunstrand No. 2 flight conveyor pump. Removed and replaced broken scraper that was jamming No. 2 flight conveyor. Bypassed lubrication low pressure shutdown switch which kept shutting down the BSB. Bored 8 feet.
11	3	394		Mucked soupy fines which were jamming the surface shaft cover doors and accumulating inside the BSB skip tubes. Cleaned propel flow control valves and ordered replacements. Stripped and lowered all concrete rings.

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
12 3	396			Bored 2 feet to complete boring cycle. Cleaned propel flow control valves continuously to complete cycle. Blocked in all rings and 10 feet of concrete forms. Changed cutter No. 25. Performed miscellaneous chores on jobsite.
13 0	396			Saturday. Scheduled maintenance shift. Worked graveyard the previous day with intent to pour the concrete liner.
14 1	396	10		Poured 10 feet of concrete liner.
15 3	400	10		Poured 10 feet of concrete liner to complete 20-foot pour. Replaced cutters No. 32 and 41. Changed No. 1 bucket elevator idler sprocket. Bored 4 feet with propel flow control valves giving continuous problems.
16 3	402			Repaired No. 1 flight conveyor chain that had pulled apart after boulder lodged in the pickup area. Replaced sticking propel flow valves with the replacements previously ordered. The grippers lost pressure causing slippage. Clutched out noisy No. 4 drive motor gear box. Bored 2 feet.
17 3	402			Replaced Denison gripper and Sunstrand No. 2 flight conveyor pumps. Relief valve and compensator on Denison pump were giving problems. Changed all hydraulic oil filters and noted that the 10 micron filters in the bucket elevator circuit were collapsed. Previously installed filters also had collapsed.

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
18	3	405		Added 2 drums FR hydraulic fluid. Rewelded No. 2 flight conveyor shoe. Bored 3 feet. Sunstrand No. 2 flight conveyor and Sunstrand dewatering pumps were erratic. Started to remove the Staffa No. 2 flight conveyor motor and companion gearbox which was ruined when the motor failed. Patched honeycombed concrete liner.
19	2	405		Installed Sunstrand No. 2 flight conveyor motor and gearbox. Started boring but Sunstrand No. 2 flight conveyor pump broke down with no replacement on hand. Removed pump and hand delivered it to the distributor for repairs. Repaired honeycombed concrete. Lowered galloway.
20	1	405		Saturday, scheduled maintenance shift. Aligned and braced No. 2 flight conveyor. Changed all hydraulic oil filters. Inspected and replaced all worn elevator buckets. Installed rebuilt Sunstrand No. 2 flight conveyor pump.
21	1	407		Bored 1½ feet. Had problems with laser target and maintaining lubricating oil pressure. Patched honeycombed concrete liner.
22	3	409		Replaced laser target and Vickers skip loading pump. Changed broken hydraulic hose. Added additional brace to No. 2 flight conveyor gearbox to eliminate binding. Lost all lubricating oil pressure with the Delaval pump. Substituted the Moyno scavenging pump for one shift.

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Bored 2 feet.
				Patched honeycombed concrete liner.
23	3	417		Replaced the inoperative (and bypassed) Vickers dual lubrication/dewatering pump that drives the Delaval pump. Restored the lubrication system to its original design.
				Repaired broken No. 1 bucket elevator chain.
				Welded center guide on No. 1 flight conveyor.
24	3	417		Cleaned forms that are supposedly responsible for the sticking and honeycombing of the concrete.
				Replaced cutters No. 16, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 38, 39, 42, 44, 45, 46, 47 and 49.
				Untangled No. 1 bucket elevator chain.
				Discussed new table of organization with Friant over the phone and Gillespie on the jobsite.
25	3	417		Continuing chipping and wire brushing concrete forms.
				Extended service lines.
				Checked and replaced worn buckets on bucket elevator.
26	2	417		Completed cleaning forms.
				Installed Remix pots and elephant trunks. Ready for concrete.
27	1	417		Saturday, scheduled maintenance shift.
				Replaced cutter No. 2.
				Changed all hydraulic oil filters.
				Adjusted pressure on all pumps.
				Checked and greased all hoist and guide ropes and scrolls.

PROJECT LOG BOOK

October, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
28	1	417	10	Poured 10 feet of concrete liner. Exposed concrete from previous pour is approximately 50% honeycombed.
29	3	420	10	Poured 10 feet of concrete liner to complete 20-foot pour. Cleaned concrete spills. Rewelded No. 2 flight conveyor chute. Bored 3 feet and experienced problems with the retracting propel cylinders. Called meeting with Gillespie and Aubuchon to discuss reason why newly installed lubrication oil filtering system was not being used. It was agreed that system will be used only when miners are working on the BSB.
30	3	429		Replaced Vickers dual lubrication/filtering pump because lubricating oil pressure dropped to 5 psig. Changed No. 2 flight conveyor chain after 53 feet of boring. During repairs noted that inching motor did not work and that the engaging cutterhead No. 6 gear box ring gear was sheared. Started removing No. 4 and 6 cutterhead drive motor assemblies.
				<u>Time usage during the one-month reporting period</u>
				Hours Availability to bore 269.8 Maintenance 322.2 Total Project Time 592.0 Actual boring 86.3 Pour concrete liner 108.5
				<u>Accomplishments</u> Feet Total shaft bored 72 Total concrete liner poured 60

PROJECT LOG BOOK

November, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	3	429		Removed crossover that connected both hydraulic tanks and prevented removal of cutterhead No. 4 drive motor. Drained and cleaned both hydraulic tanks. Cleaned main bearing and bull gear cavity through the No. 4 and No. 6 drive motor assembly cavities. Chipped, mucked and hoisted the hardened muck from the skip chairs inside the BSB skip tube. Replaced both bent skip loading hydraulic cylinders.
2	3	429		Modified crossover so that No. 4 drive motor could be removed without draining the hydraulic tanks. Added 7½ drums of FR hydraulic oil. Installed No. 6 drive motor assembly complete with inching motor. Patched honeycombed concrete liner.
3	0	429		Saturday. Scheduled maintenance shift worked graveyard the previous day.
4	1	429		Continued cleaning main bearing and bull gear cavity. Repaired sticking mancage sliding door. Removed Vickers dual lubricating/dewatering pump.
5	3	429		Completed cleaning the main bearing and bull gear cavity. Fabricated and covered No. 4 drive motor cavity with a plywood lid. Started converting to larger and improved lubrication pumping system. Patched honeycombed liner.

PROJECT LOG BOOK

November, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
6	3	435		Completed retrofitting lubrication system. Replaced Sunstrand No. 2 flight conveyor pump, relief valve in gripper circuit and pressure reducing valve in pilot valve system. Repaired gripper pump. Patched honeycombed concrete. Bored 6 feet.
7	2	436	10	Replaced same Sunstrand No. 2 flight conveyor pump changed on previous day. Bypassed Denison gripper with idle Sunstrand dewatering pump. Bored 1 foot to complete boring cycle. Stripped, lowered and blocked all concrete rings and 10 feet of form. Poured 10 feet of concrete liner. Graveyard shift did not complete pour and walked off job in protest to the scheduled Saturday work.
8	1	436		Day and afternoon shifts did not work. Cleaned concrete grout that had set in the skip hoppers. Stripped, lowered and blocked the remaining 10 feet of forms.
9	2	436	10	Completed pouring 20 feet of concrete liner. Washed cutterhead and checked cutters. Cleaned spilled concrete. Repaired No. 2 flight conveyor idler sprocket. Replaced No. 2 bucket elevator idler sprocket and worn/damaged buckets on the bucket elevator.

PROJECT LOG BOOK

November, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10	2	436		Saturday, scheduled maintenance. Changed cutters No. 19, 34 and 35. Installed rotating swivel on mancage to ease spotting door at BSB platforms. Checked and adjusted Denison gripper pump.
11	0	436		No work, miners celebrating Veteran's day.
12	1	436		Replaced cutters No. 20, 21, 22 and 40. Cleaned jobsite.
13	3	436		Removed 1 link from No. 1 flight conveyor to compensate for wear and stretch. Changed 14 buckets on No. 2 bucket elevator. Replaced Sunstrand No. 2 flight conveyor pump. Replacement did not work. Bypassed replacement pump on Sunstrand No. 2 flight conveyor with idle Sunstrand dewatering pump but could not develop sufficient pressure. Replaced Sunstrand dewatering pump. Replacement had wrong rotation.
14	3	438		Bypassed the Sunstrand dewatering pump with polishing element of the Vickers dual lubrication/polishing pump. Element did not provide sufficient volume and pressure. Stopped boring when the Sunstrand No. 1 flight conveyor pump failed. All 6 replacement pumps were sent to the distributor for repairs. Removed all suction strainers to reduce pump cavitation. Paul Sands arrived on site.
15	3	438		Installed rebuilt Sunstrand No. 1 and No. 2 flight conveyor and Vickers dual lubrication/polishing pumps. Replacement No. 2 flight conveyor pump inoperative.

PROJECT LOG BOOK

November, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Bypassed No. 2 flight conveyor pump with polishing element of Vickers dual lubrication/polishing pump.
				Attempted to bore but Denison gripper pump gave problems.
16	3	438		Retrofitted Denison gripper with Rexroth pump.
				Started removing No. 2 flight conveyor assembly which had completely failed.
				Sands returned to Spokane.
17	1	438		Saturday, scheduled work.
				Continued removing No. 2 flight conveyor assembly.
18	1	438		Started installing No. 2 flight conveyor assembly.
19	3	438		Completed installation of No. 2 flight conveyor frame.
				Waited for flight conveyor idler sprocket to be shipped from Seattle.
				Cleaned site.
				Extended service lines.
20	3	438		Installed cutterhead No. 4 drive motor assembly.
				Waited for flight conveyor idler sprocket to be shipped from Seattle.
21	3	438		Waited for flight conveyor idler sprocket to be shipped from Seattle.
				Checked lubrication passages on cutterhead No. 6 drive motor.
				Increased suction from 1 inch to 1½ inches on the Rexroth gripper pump.
22	0	438		Thanksgiving, no scheduled work.
23	0	438		Thanksgiving weekend, no scheduled work.

PROJECT LOG BOOK

November, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
24	0	438		Thanksgiving weekend, no scheduled work.
25	1	438		Flight conveyor idler sprocket arrived on Friday 23 Nov 79. Attempted to install flight conveyor idler sprocket but established that the flight conveyor frame was welded in place approximately $\frac{1}{2}$ inch higher than the idler sprocket mounting and required $\frac{1}{2}$ inch spacer to protect the sprocket seal.
26	3	439		Installed spacer under flight conveyor sprocket. Bored 1 foot. Determined that No. 2 flight conveyor was picking up all the muck because it was installed lower than No. 1.
27	3	443		Welded plate under No. 1 flight conveyor to lower the pickup area so that muck would be equally distributed between both flight conveyors. Bored 4 feet. Boulders frequently wedged in the pickup areas and had to be manually removed. Installed tees in all the pump suction and discharge lines for testing hydraulic system. Replaced cartridge on the polishing bank of Vickers dual lubrication/polishing pump that also provides power to cutterhead inching motor. Had problems with the laser target (obscured with water and muck).
28	3	448		Took readings of the entire hydraulic system to determine sources of cavitation. No cavitation was detected. Bored 5 feet. Boulders frequently wedged into the pickup areas. Discovered that the welds had broken in the newly installed No. 2 flight conveyor belly pan.

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November, 1979

DAILY ACTIVITIES

PROJECT LOG BOOK			
November, 1979			
DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)
DAILY ACTIVITIES			
29	3	448	
Rewelded No. 2 flight conveyor belly pan.			
Checked cutterhead and interface between No. 2 flight conveyor and bucket elevator to determine why the bucket elevator would not hoist muck to the hopper.			
Replaced 14 gpm cartridge with 10 gpm cartridge on polishing bank of Vickers dual lubricating/polishing pump because the larger capacity cartridge required too much horsepower.			
Replaced relief valve on No. 2 bucket elevator.			
Repaired surface truck mounted computer.			
30	2	449	
Checked interface between No. 2 flight conveyor and bucket elevator.			
Removed 1 link from No. 2 flight conveyor chain.			
Replaced Vickers No. 2 bucket elevator pump.			
Changed west laser gun.			
Bored 1 foot and Staffa No. 2 flight conveyor motor failed.			
Time usage during the one-month reporting period			
			Hours
Availability to bore			90.8
Maintenance			373.2
Total Project Time			464.0
Actual boring			27.3
Pour concrete liner			28.0
Accomplishments			Feet
Total shaft bored			20
Total concrete liner poured			20

PROJECT LOG BOOK

December, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	1	449		Saturday, scheduled maintenance shift. Removed Sunstrand No. 2 flight conveyor motor. Machine shop had to pull the tight drive gear. Replaced broken hydraulic hose. Changed damaged buckets on the bucket elevator.
2	1	451		Installed rebuilt Staffa No. 2 flight conveyor motor. Bored 2 feet. No. 2 flight conveyor chain broke.
3	3	452		Repaired No. 2 flight conveyor chain. Replaced relief valve and Sunstrand No. 1 flight conveyor pump when the system started chattering and bypassing oil at 1500 psi. Replaced bearing in No. 1 flight conveyor idler sprocket. Changed hydraulic return line filters. Hydraulic oil spills averaged about 1 gallon per hour. This was a major contributor to the main stream pollution. Bored 1 foot.
4	3	456		Repaired broken No. 1 flight conveyor chain. Lost power for one hour. Repaired open west skip hopper door. Checked No. 2 bucket elevator to determine reason it would not handle the capacity of the flight conveyor. Replaced Sunstrand No. 2 flight conveyor pump. Bored 4 feet and had continuous problems with the skips not synchronizing with the skip hoppers. Completed boring cycle.

PROJECT LOG BOOK

December, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Stripped, lowered and blocked all rings and 10 feet of concrete forms.
				Extended service lines.
5	3	456	20	Poured two, 10-foot sections of concrete liner.
				Removed and hoisted No. 2 bucket elevator chain with attached buckets.
				Cleaned spilled concrete.
6	3	456		Washed cutterhead and checked cutters.
				Replaced cutters No. 5, 6, 7, 8, 9, 10, 11 and 12.
				Changed No. 7 and 8 scrapers.
				Extended 30-inch and 36-inch ventilation pipe.
				Removed buckets from No. 2 bucket elevator chain on the surface.
				Replaced Sunstrand No. 2 bucket elevator motor.
				Installed pipes to protect the laser targets.
7	2	456		Installed No. 2 bucket elevator idler sprocket.
				Replaced cutters No. 22, 32, 33, 35, 36, 37 and 39.
				Changed broken bolts on cutters No. 10 and 12.
				Changed No. 7, 8, 9, 10, 11 and 12 scrapers. All had to be hand trimmed in the cutterhead.
				Replaced southeast torque cylinder hydraulic hose.
8	1	456		Saturday, scheduled maintenance shift.
				Installed and adjusted No. 2 bucket elevator. Started installing buckets.
				Changed No. 3, 4, 5 and 6 scrapers.

PROJECT LOG BOOK

December, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
9	1	456		Continued to install buckets on No. 2 bucket elevator chain. Repaired honeycombed concrete liner.
10	2	456		Interchanged 21 links from No. 1 with No. 2 bucket elevator chain to compensate for the difference in original assembly. Completed installing buckets on No. 2 bucket elevator chain. Replaced gripper and fast travel relief hydraulic valves. Started boring slowly to break in the new scrapers. Cleaned around surface culvert joints.
11	3	458		Experienced low lubricating pressure and replaced the lubricating element in the Vickers dual lubricating/polishing pump. Lubrication pressure remained low. Bypassed Vickers dual lubrication/polishing pump with idle Sunstrand dewatering pump. Tightened cutter bolts. Added half link to No. 2 bucket elevator chain. Bored 2 feet.
12	3	458		Replaced bearing on No. 2 flight conveyor idler sprocket that lasted for only 3 feet of boring. Extended service lines. Replaced the lubrication element on the Vickers dual lubrication/polishing pump and removed the Sunstrand dewatering pump bypass. Searched for, but did not find, lost scraper on the face. Added 2 drums FR hydraulic fluid.

PROJECT LOG BOOK

December, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Drained lubricating oil tank and started pumping out main bearing and bull gear cavity.
				Cleaned muck that had accumulated between the towers and on top of the main bearing seal.
13	3	459		Completed cleaning the lubrication system and added 5 drums of lubrication oil.
				Lost lubrication oil pressure and installed new relief valve that immediately became plugged with muck.
				Bored 1 foot; cutterhead No. 2 drive motor gear box failed.
14	2	463		Determined that cutterhead No. 4 drive motor had a damaged clutch, but that gear box was operational. Replaced No. 4 with No. 2 drive motor with clutch.
				Hoisted No. 2 drive motor gearbox to surface and covered cavity with plywood lid.
				Replaced lost wear guide on No. 2 flight conveyor and later had to cut the lost wear guide from the No. 2 flight conveyor pickup.
				Bored 4 feet.
15	1	463		Saturday, scheduled maintenance shift.
				Changed all hydraulic and lubrication oil filters.
				Performed general BSB maintenance.
16	1	465		Corrected mancage overspeed and replaced shaft cover mancage door switch.
				Bored 2 feet.
17	3	467		Changed all lubrication oil filters.
				Lowered pressure on both bucket elevators and flight conveyors to minimize pump failures.
				Bored 2 feet.

PROJECT LOG BOOK

December, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
18	3	467		Attempted to locate No. 1 bucket elevator idler sprocket cap in face (under the cutterhead). Replaced bearings and cap in No. 1 bucket elevator idler sprocket. Replaced No. 1 and No. 7 lost scrapers. Welded wedges around all the movable scrapers to prevent them from falling through the slots and into the face. Tightened loose cutter bolts. Robbins conducted jobsite meeting to implement plan to test hydraulic pressures on flight conveyors and bucket elevators.
19	3	469		Welded new wear guides on both flight conveyors. Spent remainder of day looking for missing bucket elevator idler sprocket cap and No. 1 and No. 7 scrapers. Located the cap and one scraper.
20	3	469		Cleaned propel flow control valves that were causing erratic steering. Repaired broken hydraulic hose. Adjusted No. 2 bucket elevator that continued to hang up. Repaired No. 2 flight conveyor gearbox supports. Replaced No. 2 flight conveyor chain that had apparently broken after the flight conveyor motor and gearbox had shifted. Repositioned No. 2 flight conveyor components.
21	3	469		Burned off old brackets and welded in new brackets and braces on No. 2 flight conveyor. Attempted to bore but No. 2 flight conveyor chain paddles were hanging up.

PROJECT LOG BOOK

December, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Burned 3/4-inch of length off conveyor chain paddles.
				Installed new brackets and braces on No. 1 flight conveyor motor and gearbox.
				Prepared the BSB for Christmas shutdown.
22	0	469		Saturday, no scheduled work.
23	0	469		Sunday, no scheduled work.
24	0	469		Christmas Eve, no scheduled work since miners chose to take their vacation this week. WBEC personnel returned to Tulsa to work on redesign of the hydraulic and lubrication systems.
25	0	469		Christmas, no scheduled work.
26	1	469		One shift worked to pump out shaft.
27	0	469		Vacation, no scheduled work.
28	0	469		Vacation, no scheduled work.
29	0	469		Vacation, no scheduled work.
30	0	469		Vacation, no scheduled work.
31	0	469		Vacation, no scheduled work.
				<u>Time usage during the one-month reporting period</u>
				<u>Hours</u>
Availability to bore				98
Maintenance				278
Total Project Time				376
Actual boring				37.5
Pour concrete liner				27.5
<u>Accomplishments</u>				<u>Feet</u>
Total shaft bored				20
Total concrete liner poured				20

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1 0	469			New Year's Day, no scheduled work.
2 1	469			Dewatered shaft. Attempted to bore but No. 2 flight conveyor and bucket elevator jammed continually. Cleaned trailers and shops in preparation to resume work after the holidays.
3 3	470			Switched hoses from No. 1 bucket elevator motor to No. 2 to determine if the hanging problem was caused by the drive motor or chain. Both checked out satisfactorily. Hanging problem was determined to be the worn out No. 2 flight conveyor idler sprocket. Removed, hoisted and cleaned the No. 2 flight conveyor gear box and drive motor. Changed hydraulic fluid filters.
4 3	471			Replaced No. 2 flight conveyor idler sprocket and wear shoe. Assembled flight conveyor. Reversed No. 2 bucket elevator idler that displaced Chain 3/4" from center. It was previously installed incorrectly. Replaced No. 2 flight conveyor hydraulic hose. Serviced BSB and added one drum of FR hydraulic fluid. Bored 2 feet.
5 3	471			Saturday, scheduled maintenance shift worked graveyard 4 Jan 80.
6 1	473			Dewatered shaft. Declutched cutterhead No. 3 drive motor assembly. It was making considerable noise. Cutterhead is now being driven by 4 drive motors. Bored 2 feet.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	3	475		No.2 bucket elevator continued to hang up. Low oil pressure was shutting down the BSB. Bypassed the Vickers lubrication with idle Sunstrand dewatering pump. Inspected (as required by codes) hoists and sheaves. Oiled hoisting wire ropes. Completed boring to end of 20-foot cycle. Hydraulics do not respond to lift cutterhead off the face. Stripped, lowered and blocked in concrete forming rings and first 10 feet of forms. Hung elephant trunks and prepared for concrete.
8	3	477	20	Poured first 10 feet of concrete liner, lowered and blocked in the remaining 10 feet of forms and completed pouring the liner. Cleaned concrete spills. Replaced 10 buckets on the bucket elevator. Replaced cartridge in Vickers lubrication pump. Attempted to get cutter head off the face.
9	3	477		Replaced all three propel relief valves, Dynex propel pump and cleaned all three Rexroth propel flow control valves. Rerouted Vickers lubricating oil back into lubricating system. Installed cutterhead inching motor on No. 6 drive motor. Cleaned muck from propel cylinders on BSB. Replaced original Rexroth propel flow valves with valves with larger capacity. Raised and washed cutterhead in preparation for inspecting cutters. Cleaned the inner tower.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10	3	476		Extended 30" and 36" ventilation pipes. Replaced cutters No. 14, 15, 18, 20, 25, 26, 27, 28, 29, 30, 31, 38, 39, 41, 48 and 56. Replaced electric motor on Aldrich piston (clear water) pump that dewateres the settling tank to surface. Replaced skirting on west skip hopper. Changed laser target on BSB.
11	2	476		Removed and hoisted No. 1 flight conveyor gear box and drive motor for repairs. Drained all lubricating oil in preparation to purge the system. Replaced skirting in east skip hopper. Washed out inner tower.
12	1	476		Saturday, scheduled maintenance shift. Cleaned out the bull gear and main bearing lubrication cavity through cutterhead No. 2 drive motor opening, replaced covers on openings. Rebuilt catwalk over electric driven hydraulic pumps on machinery deck. Dewatered shaft.
13	1	476		Cleaned lubrication oil tank. Added 6 drums of lubricating oil and 2 drums of FR hydraulic fluid. Changed lubrication oil filters. Dewatered shaft.
14	2	477		Cleaned and washed around side support cylinders. Installed and repaired No. 1 flight conveyor gear box and drive motor and remainder of components.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
15	3	479		Increased bucket elevator pressure to 2100 psig. Installed new air & water swivel. Added additional abrasion protection covers to hydraulic hoses located inside inner tower. Fabricated and installed cover over inspection hole in inner tower. Washed BSB and dewatered shaft. Replaced one, of two, Commercial Shearing lubrication oil drive and Vickers skip loading pump. Reversed No. 1 flight conveyor hoses that were improperly installed. Skips were out of sequence and had to be electrically synchronized. Two power failures occurred. Last one was caused by starters burning on the skip guide rope winch. Replaced them with starters from Galloway hoist. Checked side support cylinder travel. Checked and tightened cover on lubrication tank. Bored 2 feet.
16	3	484		Replaced No. 1 bucket elevator pump. Steering problems developed. Replaced all three Rexroth propel flow control valves. Readjusted pressure on No. 1 and 2 bucket elevators to 2100 psig. Adjusted chain tension. No. 2 bucket elevator still hanging up and stalling. BSB producing 70% chips but mechanical muck system is unable to pick up and convey chips into the skip hopper. No. 2 bucket elevator appears to convey most of the muck.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
17	3	485		Replaced 100 of the 114 original buckets with smaller buckets on No. 2 bucket elevator to minimize possibility of buckets hitting structures in the inner tower. Bored 1 foot then shut down when one of the four inner tower guide rollers (that keep the inner tower centered) failed. Since there was no replacement in stock, a local machine shop made and replaced the required bronze bearing. Replaced damaged No. 1 bucket elevator buckets and installed half link in chain. Adjusted No. 2 bucket elevator chain. Added half link to No. 1 flight conveyor chain.
18	2	485		Installed rebuilt inner tower guide roller. Replaced one Rexroth propel flow control valve. Adjusted pressure on lubrication oil system. Welded spacer plate underneath No. 1 flight conveyor to make pickup at same level as No. 2 flight conveyor. Changed hydraulic fluid return filters. Cleaned out trough into which cyclone separator discharges. Bored 1 foot.
19	1	488		Saturday, scheduled one work shift. Changed all lubrication oil filters. Checked packing in Moyno lubricating oil scavenging pump. Drained water from lubrication system. Repaired hydraulic leaks. Checked laser guidance system. Washed BSB and dewatered shaft.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
20	1	489		Dewatered shaft to expose cutters. Tightened loose cutter bolts. Bored 4 hours for one foot advance.
21	3	489		Replaced 50 hp electric motor on Aldrich clear water pump. Tightened hydraulic fittings to minimize leaks. Added one drum FR hydraulic fluid. Checked inner tower guide rollers. Replaced damaged No. 1 elevator buckets with those recently removed from No. 2 bucket elevator. Checked cutterhead to determine cause of poor No. 2 bucket elevator performance.
22	3	489		Removed No. 1 flight conveyor assembly and burned out the belly pan and idler sprocket support. Intent was to relocate the pickup area so that the muck will distribute itself evenly to both flight conveyors. Confirmed that the fixed scrapers are worn. Ordered replacements.
23	3	489		Replaced No. 1 flight conveyor belly pan.
24	3	489		Completed welding No. 1 flight conveyor belly pan in place. Removed cutterhead No. 3 drive motor and damaged gear box. Replaced gear box and installed drive motor. Disconnected both bucket elevator idler sprockets to gain access to the wells. Replaced No. 1 and 2 cutters. Installed No. 1 flight conveyor assembly with experimental chain.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
25	2	489		Started welding new 4" fixed scrapers near the bucket elevator wells to replace the original 7" fixed scrapers located some distance away from the wells. These scrapers will compliment, not replace the originals. Cleaned out the FR hydraulic fluid residue from the Rexroth propel flow control valves.
26	1	489		Saturday, scheduled work shift. Replaced emergency air brake on man hoist. Performed housekeeping chores on surface.
27	1	489		Completed welding 4" scrapers around bucket well. Installed No. 1 bucket elevator idler. Cleaned BSB.
28	3	490		Installed No. 2 bucket elevator idler. Changed No. 3 and 13 cutters. Replaced DeLaval lubricating oil pump. Replaced galloway hoist starters that were borrowed temporarily to make the skip guide rope winches operational. Added three drums of lubricating oil. Modified control panel to accept retrofit propel flow control valves.
29	3	492		Replaced cartridges on both Vickers lubricating pumps (1 pressure/volume and 1 continuous filtering). Down 6½ hours due to laser divergence and 1½ hours because of skip loading electrical problems. Bored two feet. Cleaned laser tube fan filters.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
30	3	496		Installed new Rexroth propel flow control valves. Reset pressure on Rexroth gripper pump. Lost considerable time due to laser beam divergence. Changed west laser filter and dried out laser tube. Bored four feet to complete 20-foot boring cycle. Lowered and blocked all concrete forming rings and forms to pour 10 feet of concrete lining.
31	3	496	20	Poured 10 feet of concrete lining. Lowered and blocked in remaining 10 feet of forms. Completed pouring concrete at 4 pm. Cleaned concrete spills. Extended 30" and 36" ventilation pipe.
				<u>Time usage during the one-month reporting period</u>
				<u>Hours</u>
				Availability to bore 210.3
				Maintenance 325.7
				Total Project Time 536.0
				Actual boring 70.3
				Pour concrete liner 50.5
				<u>Accomplishments</u>
				<u>Feet</u>
				Total shaft bored 27
				Total concrete liner poured 40

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	496		Attempted to determine reason for the laser beams divergence. Changed all hydraulic and lubricating oil filters. Replaced Rexroth flow control valve on north bank of propel cylinders. Extended service lines. Replaced cutters No. 14, 20, 34, 42, 43 and 51. Washed muck from top of main bearing (inner) seal to minimize amount of contaminant working into the main bearing and bull gear cavity.
2	0	496		Saturday, no further scheduled maintenance shifts.
3	0	496		Sunday, no further scheduled graveyard shifts.
4	2	496		Initiated two shift, five-day work week. Day shift works 7:00 am to 3:00 pm; night shift 3:00 pm to 12:00 am. Unable to bore because laser beam still diverging. Both shifts attempted to dry laser tubes with compressed air. Adjusted bucket elevator and flight conveyor chains. Replaced flow control valve for the propel cylinders with one cleaned and adjusted on jobsite.
5	2	503		Dried laser tubes with compressed air and by continuously operating the blower. Interchanged remaining propel cylinder flow control valve with the second one cleaned and adjusted on the jobsite. Dewatered shaft. Bored seven feet. Visitors from Battelle, Robbins, Cementation, Radmark and DOE arrived for meeting on the following day.

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
6	2	508		Lost approximately one hour boring time when showing visitors the BSB. Adjusted east hopper "full" indicator to correct skip overloading. Continued drying laser tubes with compressed air. Replaced flow control valve on the north bank of propel cylinders with one repaired on jobsite. Changed all hydraulic and lubricating oil filters. Bored five feet. Had difficulty keeping the laser beams on targets because of dogleg caused when the BSB wandered off course.
7	2	509		Bored 1½ feet but could not continue because of diverging laser beams. US Steel threatened to shut down project unless contamination of main stream ceased. Robbins and DOE mutually agreed to shut down the BSB in order to control the source of surface contamination and clean the BSB lubrication system to save the main bearing. Washed down the BSB. Drained lubrication oil from tank. Started removing No. 6 drive motor assembly to gain access to the main bearing and bull gear cavity.
8	2	509		Completed removing and hoisted No. 6 drive motor assembly to surface. Washed machinery deck. Removed lubrication tank to gain access to the underlying bulkheads. Started cleaning bulkheads.
9	0	509		Saturday, no scheduled work.

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
10 0	509			Sunday, no scheduled work.
11 2	509			Completed cleaning No. 5 and 6 bulkheads located under lubrication tank. Made and installed covers to independently seal the bulkheads. Started cleaning main bearing and bull gear cavity from No. 2 drive motor opening. Installed rubber skirting in east skip hopper. Reinstalled lubrication tank.
12 2	509			Completed removing solid muck from main bearing and bull gear cavity. Wiped bottom and walls to bare metal. Filled the lubrication system with six drums of oil. Changed all lubricating oil filters. Added expansion chambers to the laser blower and tube ventilation system to act as pulsation dampeners.
13 2	509			Constructed a new bridge across the ditch that carried the drained water from the skip dump site into No. 1 settling pond. Installed rubber skirting in west skip hopper. Replaced damaged clutches on No. 6 drive motor. Welded shut all holes in the outer tower that could allow muck to fall between the towers and to the top of the main bearing seal. Removed malfunctioning automatic reversing mechanism on flight conveyors.
14 2	509			Installed No. 6 drive motor complete. Checked limit switches on lubrication system.

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Installed catwalk over lubrication system.
				Inspected both man and skip hoists.
				Changed shoes on mancage crosshead.
				Waited for delivery of trough to be installed between towers to catch and divert overflow from the carousel away from the top of the main bearing seal.
15	2	509		Spent day waiting for delivery of the troughs and contractor to snake the plastic pipes through the culvert under No. 3 and 5 settling ponds.
				Installed pressure regulator in water line.
				Washed BSB.
				Installed magnetic strainer in lubrication tank.
				Removed one of the two inoperative Moyno dewatering pumps.
16	0	509		Saturday, no scheduled work.
17	0	509		Sunday, no scheduled work.
18	2	509		Removed second inoperative Moyno dewatering pump.
				Blew laser tubes with compressed air.
				Started installing aftercooler to dry compressed air.
				Changed suppliers on the trough to be fabricated for installation between towers.
				Started bundling three plastic pipes in preparation for snaking inside the culvert.
19	2	509		Picked up and started installing trough between towers.
				Snaked 20 feet of bundled plastic pipe through culvert.
				Washed and cleaned BSB.

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
20	2	509		Continued installing trough. Snaked total of 200 feet of bundled plastic pipe in culvert.
21	2	509		Completed installing trough. Installed ring directly under carousel to compliment trough. Completed snaking total of 380 feet of bundled plastic pipe under No. 3 and 5 settling ponds. Cleaned main bearing seal between towers.
22	2	513		Pumped 50 gallons of water from the main bearing and bull gear cavity that had apparently worked its way through the main bearing seal when washing the BSB. Poured concrete plugs at each end of the plastic pipe to isolate the pipe from the replaced leaking culverts. Bored four feet.
23	0	513		Saturday, no scheduled work.
24	0	513		Sunday, no scheduled work.
25	2	513		Unable to bore due to continuing laser beam divergence problems. Cause not determined. Replaced No. 6 drive motor gearbox that became noisy. Changed all lubricating oil filters. Pumped water from main bearing and bull gear cavity. Sealed the intake of the plastic pipe with the non-leaking portion of culvert in the manhole. Changed lubrication relief valve. Visited by Inspector General team.

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
26	2	514		Lost four hours boring time due to laser problems. Repaired west hopper discharge door that failed to close. Changed two lubrication oil filters. Installed a wiper to clean the magnetic sensor on the carousel west discharge gate. Extended service lines. Bored less than one foot.
27	2	517		Lost 3½ hours boring time because of malfunctioning lasers. Replaced all propel cylinder flow control valves. Bored four feet and continued having problems with the propel flow control valves. Completed boring cycle.
28	2	517		Stripped, lowered and blocked all the rings and 10 feet of forms. Gaged cutters. Changed all hydraulic and lubricating oil filters. Ready to pour concrete.
29	2	517	20	Poured 20 feet of concrete in two lifts. Poured concrete pad for surface transformer. Cleaned spilled concrete. Installed wear shoes on No. 1 and 2 flight conveyors. Removed one-half link from both No. 1 and 2 flight conveyor chains. Cleaned main bearing seal between towers.

PROJECT LOG BOOK

February, 1980

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

Time usage during the one-month reporting period

Hours

Availability to bore 170.3
Maintenance 149.7
Total Project Time 320.0

Actual boring 35.9

Pour concrete liner 26.8

Accomplishments

Feet

Total shaft bored 21

Total concrete liner poured 20

PROJECT LOG BOOK

March, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1 0	517			Saturday, no scheduled work.
2 0	517			Sunday, no scheduled work.
3 2	517			Thawed and replaced damaged water lines that froze during the weekend. Replaced one bucket on No. 1 bucket elevator. Removed surface laser guns and plumbed laser tubes to determine internal condition and alignment. Confirmed that they were within tolerances.
4 2	517			Installed one laser gun over west slickline to determine difference in laser beam deflection between a slickline surrounded by air and the laser tube embedded in concrete. Test was abandoned at end of day because temperature did not change sufficiently to cause a deflection. Relocated laser gun to original position over laser tube. Bored one foot. Pumped water from main bearing and bull gear cavity. Started replacing one of the three north bank of propel cylinders that failed in the rod section where the threaded portion meets the ball. Removed old manhole at the transition where the discharge of the existing culvert meets the intake of the installed plastic pipe.
5 2	518			Replaced the experimental chain that broke when the wear shoe on No. 1 flight conveyor broke. Completed replacing propel cylinder. Clutched out noisy No. 4 drive motor gear box. Extended 30-inch and 36-inch ventilation lines. Excavated manhole and shoring walls in preparation for pouring concrete.

PROJECT LOG BOOK

March, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
6	2	518		Removed, disassembled and checked No. 4 drive motor gear box. Found nothing wrong. Spent 2½ hours attempting to determine reason No. 1 flight conveyor keeps hanging up. Started replacing overcenter valves on all propel cylinders with pilot operated relief valves. Continued preparing manhole for pouring concrete. Extended road so that redi-mix trucks could drive to manhole location.
7	2	518		Discovered that No. 1 flight conveyor belly pan was bent and cracked. Spent remainder of day removing the flight conveyor assembly and jacking the belly pan back into place. Installed planks from road extension to manhole location.
8	0	518		Saturday, no scheduled work.
9	0	518		Sunday, no scheduled work.
10	2	518		Welded No. 1 flight conveyor belly pan. Installed idler sprocket mounting with pin. Completed replacing overcenter propel cylinder valves with pilot-operated check valves. Poured three yards of concrete into the manhole excavation to form a slab and wall footing.
11	2	518		Installed No. 1 flight conveyor assembly. Added scraper to keep the idler sprocket clean. Welded lip on the inner tower slip joint to keep muck from working through the joint and into the main bearing seal. Started laying concrete block manhole walls.

PROJECT LOG BOOK

March, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
12	2	520		Replaced six buckets on No. 1 bucket elevator. Changed wear shoes on mancage crosshead. Bored one foot. Having continuous rain. All the settling ponds are acting as catch basins and are beginning to overflow into the main stream.
13	2	521		Aligned No. 1 flight conveyor gear box. Bored one foot. Replaced No. 1 bucket elevator chain with attached buckets that broke and fell into the cutterhead. Experienced two power shutdowns that precluded any further boring this day. Visited by Palowich, Evans and Good of DOE, Pittsburgh.
14	2	521		Troubleshooted electrical systems and concluded that the shutdowns were caused by low air pressure to the clutches or the limit switches in the headframe. Discovered that damage to No. 2 flight conveyor belly pan was similar to the recent damage to No. 1. Removed flight conveyor assembly and burned off belly pan. Tacked new belly pan into position.
15	0	521		Saturday, no scheduled work.
16	0	521		Sunday, no scheduled work.
17	2	521		Welded No. 2 flight conveyor belly pan in place. Rebuilt flight conveyor assembly on surface. Replaced 21 buckets, damaged chain pins and keys on No. 1 bucket elevator. Pumped water from No. 2 to 3 pond to minimize possibility of the high dammed water breaching No. 2 dam.

PROJECT LOG BOOK

March, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
18	2	523		Assembled No. 2 flight conveyor in cutterhead. Repaired No. 1 flight conveyor leaking hose. Bored one foot. Stopped BSB several times to remove large slabs of shale that plugged the flight conveyor pickups. Installed new fence posts. Plugged the void between the plastic pipe and culvert, in the manhole, with concrete.
19	2	525		Increased bucket elevator pressure from 2100 to 2400 psi but did not increase the boring rate above one-half foot per hour. Becoming evident that the recently installed 4-inch fixed scrapers are not keeping the muck away from the buckets. Bored two feet. Tarred inside of concrete block manhole walls. Both No. 1 and 2 ponds have eroded their dams and are flowing into No. 3 pond. No. 5 dam is leaking 25 gpm of contaminated water into the main stream.
20	2	528		Raised No. 2 bucket elevator idler sprocket 6 inches to minimize buckets digging into the built up muck in the face. Extended and raised No. 2 flight conveyor chute that interfaces with No. 2 bucket elevator. Boring rate doubled and Cementation started making similar modifications to the No. 1 flight conveyor/bucket elevator system. Cleaned No. 4 and No. 6 motor contacts because motors would not start. Replaced No. 2 flight conveyor hydraulic hose inside tower. Bored three feet.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
21	2	533		Changed hydraulic and lubricating oil filters. Waited for boring water one-half hour. Bored five feet. Recommended that the cutterhead be blocked and the original 7-inch fixed scrapers replaced.
22	2	533		Saturday. Worked one shift to replace mancage socket.
23	0	533		Sunday, no scheduled work.
24	2	536		Experienced four hours of electrical problems. One problem corrected by replacing the limit switch on the shaft collar door. The other, caused by the skips getting out of synchronization, was not corrected. Tarred outside of concrete block manhole walls and made manhole ready for backfilling. Settling ponds still overflowing as previously reported.
25	2	539		Bored three feet to complete boring cycle. Decreased No. 2 flight conveyor hydraulic pressure to minimize overloading the bucket elevator. Stripped, lowered and blocked all the rings and 10 feet of forms. Settling ponds still badly contaminating main stream.
26	2	539		Modified forms to establish recesses in the concrete liner for installing underground laser guns. Burned off projection on No. 1 flight conveyor belly pan that was hanging up chain. Greased BSB. No. 5 dam still leaking 15 to 20 gpm of contaminated water into main stream.

PROJECT LOG BOOK

March, 1979

DAILY ACTIVITIES

PROJECT LOG BOOK			
March, 1979			
DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)
DAILY ACTIVITIES			
27	2	541	20
Poured 20 feet of continuous concrete liner in five hours.			
Cleaned spilled concrete.			
Took movies of the 15 to 20 gpm contaminated water leaking from No. 5 dam into main stream. Will mail to Sands.			
28	2	543	
Extended ventilation and service lines 20 feet.			
Lowered galloway.			
Declutched No. 4 cutterhead drive motor.			
Bored two feet in 5½ hours or 0.36 feet per hour.			
29	0	543	
Saturday, no scheduled work.			
30	0	543	
Sunday, no scheduled work.			
31	2	544	
Cleaned corroded contacts on No. 4 cutterhead drive motor.			
Bored two feet with higher than normal 1200 psi propel pressure.			
Had continuous problems with grippers slipping.			
Replaced cutters No. 37, 55, 32, 50, 54, 36, 45 and 53.			
<u>Time usage during the one-month reporting period</u>			
			Hours
Availability to bore			161.4
Maintenance			182.6
Total Project Time			344.0
Actual Boring			56.1
Pour concrete liner			20
<u>Accomplishments</u>			
			Feet
Total shaft bored			27
Total concrete liner poured			20

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PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	547		Replaced cutters No. 21, 31, 33, 38, 44, 47 & 52. Changed hydraulic hoses on Denison gripper and Sunstrand dewatering pumps. Replaced Rexroth propel flow control valve on north-south cylinder bank. Bored 3 feet. There was no indication that the new cutters helped the boring rate.
2	2	550		Replaced Vickers No. 2 bucket elevator pump. Repaired inoperative penetration rate gage. Troubleshoot and repaired 50 hp electric motor that drives the Vickers skip loading and Sunstrand No. 1 flight conveyor pumps. Bored 2 feet.
3	0	550		Holiday. Miners traded their scheduled miner's holiday for this day to get a 4-day Easter holiday.
4	0	550		Good Friday, no scheduled work.
5	0	550		Saturday, no scheduled work.
6	0	550		Easter Sunday, no scheduled work.
7	2	552		Replaced cutters No. 47, 48, 49, 50, 51 & 52. All failed due to bad bearings. Three created considerable smoke and noise when ground flat. Bored 2 feet. No attempt was made to stop the flow of contaminated water through No. 5 dam. Prepared to relocate the surface exhaust fan in preparation for dry boring.

PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
8	2	559		Lost 1/2 hour retriipping galloway breaker after storm. BSB overdrilled and bucket elevators were unable to keep up with the flight conveyors. Muck hung up in hoppers and had to be manually washed out. Carousel overflowed several times because both carousel doors closed when the skip hoisting system lost synchronization. Tightened cutter bolts. Bored 7 feet to complete boring cycle. Had problems regripping because BSB was out of alignment with shaft walls. Lowered service lines and slicklines. Continued preparations to relocate surface exhaust fan. No efforts were made to contain No. 5 dam to prevent contaminated water from dumping into the main stream.
9	2	559		Washed cutterhead and determined that 23 cutters had to be changed. Changed all hydraulic and lubrication oil filters. Stripped, lowered and blocked all rings and concrete forms. Replaced cutters No. 43, 34 & 41. Ready for concrete pour the following day.
10	2	559	20	Poured 20 feet of concrete as one pour in 4 hours. Cleaned up after concrete pour. Replaced cutters No. 10, 12, 17, 19, 23, 29, 40 & 42. Poured concrete footings for exhaust fan on surface.

PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
11	2	559		Extended 30" and 36" ventilation pipes. Replaced cutters No. 10, 12, 17, 19, 23, 29, 40 & 42. Removed 1 link from No. 2 flight conveyor chain. Replaced 9 buckets on No. 1 bucket elevator.
12	0	559		Saturday, no scheduled work.
13	0	559		Sunday, no scheduled work.
14	2	559		Replaced No. 1 flight conveyor motor, gearbox and chain. Removed and hoisted to surface, No. 1 bucket elevator chain complete with attached buckets.
15	2	559		Installed new No. 1 bucket elevator chain, drive motor with sprocket and buckets. Adjusted No. 1 flight conveyor and No. 1 bucket elevator chains. Replaced cutters No. 25 and 27. Installed lights under galloway to illuminate BSB top deck. Added one drum of FR hydraulic fluid.
16	2	559		Retrofitted Sunstrand No. 1 flight conveyor with Rexroth pump. Welded cover plate over center cutters. Bored intermittently because boulders continually jammed No. 1 flight conveyor pickup. Replaced broken hydraulic hose between towers. Added one drum of FR hydraulic fluid.

PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
07	2	559		Added 2 more drums of FR hydraulic fluid. Removed inoperative Sunstrand No. 2 flight conveyor pump for repairs and used idle Sunstrand dewatering pump as temporary replacement. Located and repaired the ground fault and alignment problem with 50 hp electric motor that drives Vickers skip loading and Sunstrand No. 1 flight conveyor pumps. Relay problems caused air clutches to disengage when the flight conveyors reversed. BSB shut down for 2 hours at end of day because of inability to get power from the galloway. Attempted to flocculate No. 5 pond with alum. Water became acid and had to be neutralized by pumping into No. 3 pond.
08	2	565		Experienced over 2 hours' delay troubleshooting control power switch and with further power shutdowns. Installed rebuilt Sunstrand No. 2 flight conveyor pump. Trimmed No. 2 flight conveyor paddles that were hanging up. Bored 6 feet. Grouted outside of culvert pipes in No. 5 dam to reduce total dam leakage by one-half.
09	2	565		Saturday. Relocated exhaust fan from ground position to one approximately 20 feet above ground level and on the west side of the headframe. Discharge has 2,20-foot lengths of 36" Maylor pipe and looks north. Installed compressed air aftercoolers above the compressor housing. Cleaned up site in preparation for the vacuum BSB conversion.
10	0	565		Sunday, no scheduled work.

PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
21	2	573		Changed cartridge in the Vickers lubrication pump. Burned out a piece of scrap metal (origin unknown) wedged in No. 1 flight conveyor pickup. Bored 8 feet. Relocated 2 power cables on headframe because of new exhaust fan location.
22	2	578		Removed inoperative Sunstrand No. 1 flight conveyor pump for repairs and substituted Sunstrand dewatering pump as a temporary replacement. Trimmed No. 1 flight conveyor paddles several times to minimize hangups. Replaced broken hydraulic hose in propel circuit. Bored 5 feet. Declutched No. 1 cutterhead drive motor because of an apparently failing gearbox.
23	2	577		Added 2 drums of FR hydraulic fluid and 1 drum of lubricating oil. Bored to complete 20-foot boring cycle. Stripped, lowered and blocked rings and forms. Ready to pour concrete on the following day.
24	2	577	20	Poured 20 feet of monolithic concrete liner in less than 4 hours. Cleaned up concrete splatter and all handling equipment. Installed rebuilt Sunstrand No. 1 flight conveyor pump. Changed all hydraulic oil filters. Removed 1/2 link from No. 2 bucket elevator chain. Constructed gravel packed drainage ditches around No. 5 pond to catch and divert rain runoff water.

PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
25	2	577		Extended all service and ventilation lines. Removed No. 2 flight conveyor and welded cracks in belly pan. Adjusted tension on both bucket elevators. Replaced No. 2 cutter.
26	2	577		Saturday, no scheduled work. Outside contractor working on the settling ponds was called to repair breach in No. 3 dam.
27	0	577		Sunday, no scheduled work.
28	2	578		Replaced cutters No. 19, 20 and 39. Installed No. 2 flight conveyor drive motor, new idler sprocket, new chain and idler sprocket cover. Bored 1 foot. Grippers lost pressure at end of shift. Did not work on the settling ponds because of rain over weekend.
29	2	584		Cleaned gripper hydraulic pressure reducing valves to reinstate gripper pressure. Replaced broken hydraulic hose within inner tower. Replaced damaged Vickers lubricating pump coupling. Cleaned and dried out contacts on 50 hp electric motor that drives Vickers skip loading and Sunstrand No. 1 flight conveyor pumps. Cementation pumped decant from No. 1 pond into No. 4 pond so that outside contractor can clam solids out of No. 1 pond. Overflow from No. 4 empties into No. 3 pond and leaks through porous formation through No. 5 dam and into main stream. Leakage was muddy water.

PROJECT LOG BOOK

April, 1980

DAILY ACTIVITIES

30	2	584	Had continual hangups with No. 1 flight conveyor. U.S. Steel shut project down because the 15 gpm leakage through No. 5 dam was badly contaminating the main stream. Constructed sump between No. 5 dam and main stream to contain all the No. 5 dam leakage with intent that when full, the contaminated water would be pumped back into No. 3 pond. Pumped 20 sacks of neat cement into No. 5 dam to seal leaks. Installed valve at end of No. 3 pond riser pipe to increase dam capacity.																											
31	2	584	Intermittently pumped seepage from No. 5 dam back into No. 3 pond. Treated No. 3 pond with alum to flocculate fines. U.S. Steel will not allow further boring until Robbins makes those site construction changes to assure that there will be zero discharge of contaminated water into the main stream.																											
			<table><tr><th colspan="2"><u>Time usage during the one-month reporting period</u></th><th><u>Hours</u></th></tr><tr><td>Availability to bore</td><td></td><td>NA</td></tr><tr><td>Maintenance</td><td></td><td>NA</td></tr><tr><td>Total Project Time</td><td></td><td>328</td></tr><tr><td>Actual boring</td><td></td><td>60.8</td></tr><tr><td>Pour concrete liner</td><td></td><td>NA</td></tr><tr><td colspan="2"><u>Accomplishments</u></td><td><u>Feet</u></td></tr><tr><td>Total shaft bored</td><td></td><td>40</td></tr><tr><td>Total concrete liner poured</td><td></td><td>40</td></tr></table>	<u>Time usage during the one-month reporting period</u>		<u>Hours</u>	Availability to bore		NA	Maintenance		NA	Total Project Time		328	Actual boring		60.8	Pour concrete liner		NA	<u>Accomplishments</u>		<u>Feet</u>	Total shaft bored		40	Total concrete liner poured		40
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Total shaft bored		40																												
Total concrete liner poured		40																												

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	584		Replaced leaking Staffa No. 2 bucket elevator motor. Removed cover and checked hydraulic swivel for leaks. Removed all scrapers from the cutterhead. Welded shut the temporary inspection door previously cut in the outer tower. Pumped leakage from sump below No. 5 dam into No. 3 pond. Grouted No. 5 dam. Added 75 pounds alum to No. 3 pond.
2	2	584		Installed new scrapers with wedges to prevent the scrapers from falling through the slots and into the face. Removed dust suppression nozzles from the cutterhead. Reconstructed French drains on the east and west sides of No. 5 pond to incorporate berms to stop and deflect rain runoff into the main stream. Pumped leakage from sump below No. 5 dam into No. 3 pond. Grouted No. 5 dam. Added 100 lbs of alum to No. 3 pond and agitated mixture with 4" dewatering pump. Cementation, with WBEC attending, met with US Steel to discuss ongoing and proposed site improvements to eliminate stream contamination.
3	0	584		Saturday, no scheduled work.
4	0	584		Sunday, no scheduled work.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
5	2	584		Dewatered shaft. Removed cutterhead No. 1 drive motor assembly, repaired clutch and replaced gearbox. Drained lubricating oil and cleaned bull gear and main bearing cavity through cutterhead No. 1, drive/motor/assembly opening. Fabricated and installed new lubrication tank cover. Received approval from US Steel and started pumping supernatant from No. 3 pond into main stream. Cementation, with WBEC attending, met with CH₂M Hill to discuss 2 May 80 meeting with US Steel and to determine action CH₂M Hill is taking to eliminate the stream contamination.
6	2	584		Installed lubrication oil return line filters and added 7 drums of lubricating oil. Installed cutterhead No. 1 drive motor. Started sealing assembly joints in the towers to restrict the flow of wash water to the bull gear and main bearing seal. Cleaned and replaced the dust suppression nozzles on the cutterhead. Performed miscellaneous maintenance work on the BSB. Cementation continued to pump supernatant from No. 3 pond into the main stream. Subcontractor stripped and stored topsoil from No. 6 site and used clay underneath to build up the dams on west and north side of No. 3 pond. Installed diversion pipe under No. 3 north dam to prevent No. 2 pond water from damming during construction. Cementation treated No. 2 pond with 100 lbs of alum with intent to use this pond for shaft water.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
7	2	584		Completed sealing the assembly joints in the towers. Replaced both bucket elevator idler sprockets and shafts. Dried out connections on the 50 hp electric motor that drives the skip loading and No. 1 flight conveyor systems. Dewatered the shaft. Subcontractor continued to add to the No. 3 west and north dams with material dozed from No. 6, fine-solids site. Cementation increased the height of manhole walls. Cementation had a meeting, with WBEC attending, to discuss the action being taken to dispose of the flocculent from No. 1 pond.
8	2	584		Removed Staffa No. 1 bucket elevator drive motor with sprocket. Poured two additional footings to support additional lengths of ventilation pipe to be added to the spray pipe. Subcontractor continued to add to No. 3 west and north dams with material dozed from No. 6 fine-solids site. Cementation continued to enlarge manhole walls. Constructed desliming test pit. Started construction of spillway below No. 5 dam.
9	2	584		Installed rebuilt Staffa No. 1 bucket elevator drive motor and new sprocket. Installed cutterhead No. 2 drive motor assembly gear box and clutch into cavity. Repaired overhead air hoist from machinery deck. Assembled spare Staffa flight conveyor motor with sprocket. Dewatered the shaft.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Subcontractor completed increasing height of No. 3 dam and started constructing diversion berms north of No. 1 pond. Continued construction of No. 6 site by piling borrow for future cover.
				Cementation continued increasing manhole walls.
10	0	584		Saturday, no scheduled work.
11	0	584		Sunday, no scheduled work.
12	2	584		Stripped and lowered all concrete forming rings.
				Removed cutterhead No. 4 drive motor to expose damaged gear box.
				Fabricated mounts for extending the ventilation pipe at the collar.
				Subcontractor continued to excavate No. 6 fine-solids site. Started improving No. 5 pond east and west berms.
				Cementation completed manhole walls. Pumped water from sump under No. 5 dam to No. 3 pond.
13	2	584		Removed and hoisted damaged No. 4 cutterhead gear box to surface.
				Washed cutterhead and pumped water from shaft to prepare for measuring cutter wear.
				Subcontractor graded the berm on north side of No. 1 pond so that deflected water will flow into a ditch alongside the jobsite entrance road.
				Packed and graded fill used to repair No. 2 breached dam. Backfilled manhole. Continued working on No. 6 fine-solids site.
				Cementation completed the construction of No. 5 dam spillway.
14	2	584		Gaged and replaced cutter No. 15, 33, 36 and 44.
				Tightened loose cutter bolts.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
15	2	584		Repaired and installed cutterhead No. 4 gear box. Replaced original clutch and drive motor. Dewatered shaft. Rain precluded any construction. Cementation kept pumping water into No. 3 pond from the sump that catches No. 5 dam leakage. Checked dust control spray nozzles on cutterhead. Checked all BSB functions in preparation to start boring. Dried connections on 50 hp electric motor that drives No. 1 flight conveyor and skip loading systems. Replaced Volvo motor that measures actual penetration rate. Installed surface pump that recycles No. 2 pond water to shaft. Completed fabricating steel supports to extend exhaust ventilation line. Constructed ditch to divert water from the shaft collar pad away from the site. Changed No. 14 and 16 cutters. Started to bore to break in the new scrapers. Subcontractor did not work. Cementation installed a ladder in manhole. No. 3 pond leaked through a porous formation under No. 5 pond and through No. 5 dam.
16	2	587		Replaced Staffa No. 1 flight conveyor drive motor and sprocket. Installed supports and extended shaft collar ventilation line 2 lengths or 40 feet.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Bored 2 feet and encountered large boulders typical of those the BSB generates when on top of a coal seam.
				Replaced gripper pressure relief valve.
				Subcontractor did not work.
				Cementation grouted plastic pipe into No. 3 pond riser to increase the pond capacity.
17	0	587		Saturday, no scheduled work. Paul Sands and WBEC inspected the site and worked on scheduling.
18	0	587		Sunday, no scheduled work.
19	2	589		Started boring but stopped when it was determined that the BSB had lost considerable lubricating oil. Could not determine cause but suspected that air pressure could have blown oil out of the bull gear and main bearing seal.
				Cleaned accumulated muck from the top of the bull gear and main bearing seal.
				Added 5 drums (330 gals) of lubricating oil.
				Bored 2 feet.
				Subcontractor did not work because of considerable rain over the weekend.
				Cementation filled in the low point in the jobsite entrance road that trapped the water deflected by No. 1 pond berm.
				No. 3 pond is within one foot of the highest water mark.
				French drains to the east and west of No. 5 pond have been eroded at the discharge.
20	2	591		Replaced the recently installed Rexroth gripper pump but later determined that the problem was with adjustments, not the pump.
				No. 2 flight conveyor motor supports broke and were replaced.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Bored 2 feet and lost gripper pressure. Subcontractor did not work. Cementation constructed a 1 foot deep ditch filled with gravel alongside the road from No. 5 dam to a culvert that directs all water underneath the road and into the main stream. Determined that a mixture of 1 part of hydrated lime and 2 parts of fly ash would flocculate the slimes from No. 1 pond. Friant and Boyce of Robbins and Paul Sands of DOE presented J. Y. O'Neal and E. Muldoon of US Steel the new proposed boring schedule. US Steel rejected it and requested that Robbins cease boring 30 Jun 80.
21	2	598		Reset pressure on Rexroth gripper pump. Bored 7 feet to complete boring cycle. Advanced slicklines. Replaced one of two 600 cfm stationary compressors on surface. Added 1 drum of lubricating oil. Added 50 lbs of alum to No. 5 pond and 250 lbs to No. 3. R. T. Merritt and L. Felts of TRW visited site in preparation to writing their report to DOE.
22	2	598		Stripped, lowered and blocked all concrete forming rings and 20 feet of forms. Extended service lines and prepared for pouring concrete. Had considerable rain in the morning. No. 5 pond was within 3" of overflowing and No. 3 pond raised another foot. Cementation took samples in the morning and obtained US Steel permission to pump the supernatant into the main stream.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
23	2	598	20	Poured 20 feet of concrete liner in 3 hours. Spent the remainder of the day cleaning concrete spills and extending ventilation lines. Pumped No. 3 and No. 5 ponds into main stream.
24	0	598		Saturday, no scheduled work.
25	0	598		Sunday, no scheduled work.
26	0	598		Memorial day, no scheduled work.
27	0	598		All effort was made to prepare the BSB for 10 feet of uninterrupted, troublefree dry boring. Changed No. 31 and 39 cutters. Replaced broken elevator buckets. Checked and adjusted both flight conveyors. Tightened all cutter bolts. Installed metal frames with plastic covers on top of skip hoppers to contain dust. Performed additional routine maintenance. No. 3 and No. 5 ponds are dewatered. No. 5 dam was leaking approximately $\frac{1}{4}$ gpm of clear water. Boyce of Robbins was on site to witness dry boring.
28	2	600		Entire day shift was spent attempting to convert from wet to dry drilling. During the transition, the muck became sticky and hung up in the flight conveyors. The accumulated muck had to be cleaned out by hand. Night shift wet bored 2 feet to purge the muck handling systems. Cleaned out muck spillage in the skip tubes. Replaced broken hydraulic hose.

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

				PROJECT LOG BOOK
				May, 1980
DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
DAILY ACTIVITIES				
				Performed routine maintenance.
				Boyce of Robbins was still on site.
29	2	604		Bored 4 feet attempting to convert from wet to dry.
				Changed all hydraulic and lubrication oil filters.
				Replaced cartridge in Vickers lubricating oil pump.
				Removed 50 hp electric motor that drives No. 1 bucket elevator and lubricating oil pumps.
				Replaced No. 1 flight conveyor pinion gear.
30	2	604		Replaced 50 hp electric motor.
				Replaced Staffa No. 1 flight conveyor drive motor.
				Removed No. 2 dewatering cyclone located on top of the BSB.
				Bored, without any advance. Nachod and Alabayrak of Fuel & Minerals Resources observed the attempt.
				Removed and replaced bucket elevator idlers to inspect new scrapers.
				Too many interruptions occurred to dry out muck.
31	0	604		Saturday, no scheduled work.
				<u>Time usage during the one-month reporting period</u>
				<u>Hours</u>
Availability to bore				90.1
Maintenance				245.9
Total Project Time				336.0
Actual boring				28.9
Pour concrete liner				19.5
<u>Accomplishments</u>				<u>Feet</u>
Total shaft bored				20
Total concrete liner poured				20

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	0	604		Sunday, no scheduled work.
2	2	609		Replaced fast retract propel and torque cylinder control valves. Removed one-half link from No. 1 bucket elevator and one link from No. 1 flight conveyor chains. Resequenced skips. Bored one foot dry and four feet wet. Decision made to abandon additional attempts to bore dry.
3	2	613		Replaced one, of five, pressure reducing valves and one north and one south Rexroth propel flow control valves. Changed No. 2 flight conveyor hose located in the inner tower. Replaced Sunstrand No. 2 flight conveyor pump. Replaced sheared bolts on No. 2 bucket elevator idler bracket. Added two drums of FR hydraulic fluid. Bored four feet.
4	2	614		Repaired No. 1 flight conveyor belly pan. Replaced leaking relief valve and east and west Rexroth propel flow control valves. Having continuous problems with No. 1 flight conveyor hanging up. Bypassed the automatic skip loading system because the west skip door would not close. Operating the doors manually.
5	2	614		Changed wear guide on No. 1 flight conveyor. Repaired cracked No. 1 flight conveyor belly pan.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

6 2 614

Removed the fast reset check valves from the propel circuit (used to lower the shield during regrip) because it was determined that they are no longer needed. The weight of the shield gives the same lowering speed.

Cleaned all the Rexroth propel flow control valves.

Installed new pilot pressure reducing and a four-way directional valve in the propel circuit.

Replaced Vickers skip loading pump.

Unable to bore due to the divergence of the laser beams.

Started installing bracket to mount underground laser guns.

Extended service lines and slicklines.

Klein and Owens of Robbins visited site.

BSB continues to be shut down because of the laser beam divergence.

Replaced the second Vickers skip loading pump. Adjusted pressure on both pumps.

Installed additional four-way directional valve for second bank of propel cylinders and shuttle valve to actuate cutterhead inching motor.

Lost power on the skip rope tensioning winches and spent one-half shift attempting to locate problems.

Continuing to install underground laser gun.

7 2 614

Saturday.

Replaced both Sunstrand flight conveyor with new Rexroth pumps. The Sunstrand automatically compensates for pressure and volume whereas the Rexroth maintains constant pressure and volume and must be adjusted manually. The replacement gives $(50-27)=23$ additional gpm per pump.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
8	0	614		Sunday, no scheduled work.
9	2	616		Completed installing underground laser gun. Dewatered shaft. Added two drums of FR hydraulic fluid which was lost when replacing the pumps. Raised No. 1 bucket elevator idler sprocket approximately 5 inches to keep the buckets from digging into the face. Removed one link from the chain to compensate for the distance. Replaced two pilot pressure reducing valves that were plugged with FR fluid residue. Completed piping the Rexroth flight conveyor pumps. Bored two feet.
10	2	616		Removed one link from No. 2 flight conveyor chain to compensate for wear and stretch. Replaced wear guide on No. 2 flight conveyor. Adjusted pressure on Rexroth gripper pump. Freed the hydraulically operated knuckle joint on west skip hopper door. Bored one foot to complete 20-foot boring cycle. Stripped, lowered and blocked in all concrete forming rings and the 20-foot form.
11	2	616		Poured 20 feet of concrete in 2½ hours. Spent remainder of day washing cutterhead, dewatering shaft and preparing to remove both flight conveyors. Assembling mixing plant on surface to cake the flocculant from No. 1 pond.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT)	
12	2	616		Visited by five representatives of Foster Miller and three from Dravo to observe the operation of the BSB and concrete lining. Both companies are involved in a DOE contract involving slip forming concrete from the top to the bottom while the BSB bores.
12	2	616		Both flight conveyor belly pans have broken welds and are cracked beyond repair. Continued to remove both flight conveyors.
				Inspected cutters and determined that 20 had to be replaced.
				Started to change the hydraulic system so that the Dynex pump takes most of the Rexroth load and eliminated the troublesome pressure reducing valves.
				Continuing assembling surface mixing plant.
13	2	616		Completed removing No. 1 flight conveyor assembly and belly pan.
				Welded No. 1 flight conveyor belly pan in place and started tacking in assembly.
				Continued assembling surface mixing plant.
14	2	616		Saturday.
				Completed welding in No. 1 flight conveyor assembly and started bolting on components.
				Having problems with newly designed, one piece idler sprocket on the flight conveyor. It is undersized and will not fit on existing pins. It will have to be remachined.
				Completed removing No.2 flight conveyor assembly.
				Completed assembly of surface mixing plant.
15	0	615		Sunday, no scheduled work.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
16	2	616		Weekly safety meetings have deteriorated to nit picking about non-safety related items. Dewatered shaft so that men could work in the cutterhead. Completed bolting of all No. 1 flight conveyor components. Tacking No. 2 flight conveyor belly pan to cutterhead. Changed 13 buckets on No. 1 bucket elevator. Intended to replace existing flight conveyor motors with larger Staffa motors when replacing the complete flight conveyor assemblies. Discovered that the adapter plates were machined improperly.
17	2	616		Completed welding No. 2 flight conveyor belly and assembly. Started bolting on the components. Replaced 27 broken buckets on No. 2 bucket elevators and 5 on No. 1 bucket elevators with the buckets removed from No. 2 bucket elevator. It was assumed that the buckets were too large and hanging up in the inner tower. Tacked hold down braces to both flight conveyor gear boxes. Started clamming flocculent from No. 1 pond, mixing the flocculent with sacked fly ash and dehydrated lime in the mixer and trucking the solids to No. 6 site for disposal.
18	2	616		Dewatered shaft so that men could work in the cutterhead. Replaced cutters No. 21, 24, 26, 27, 28, 29, 30, 32, 34, 35, 37, 38, 40, 41, 42, 43, 44, 45, 46 and 56. Ground one-half inch of metal from No. 2 flight conveyor center island because idler sprocket would not fit. This was an assembly error. Processed and disposed of 130 yards of mixed solids at No. 6 site. Rasmussen of Battelle on site.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
19	2	616		In a prior meeting that WBEC was not invited to attend, the decision was made to repower the entire mechanical muck pickup system since all the parts were in stock on the site. When the attempt was made to repower, the adapters and associated fabrications were either machined incorrectly or not machined locally as intended. The decision was reversed so that the BSB would continue to bore with the mechanical muck pickup as is and it will be repowered when the parts are in hand. Completed No. 1 flight conveyor assembly. Chiseled out shelves in the concrete liner to house the underground laser batteries. Processed and dumped approximately 125 yards of mixed solids into No. 6 site.
20	2	619		Completed No. 2 flight conveyor assembly. Installed two muck scrapers (made at the jobsite) to keep the flight conveyor idler sprocket chain guides clean. Changed all lubrication oil filters. Extended 20 feet of each of 30-inch and 36-inch ventilation pipes. Bored three feet.
21	2	622		Saturday. Adjusted low gripper pressure. Cleaned corroded connectors on the 50 hp electric motor that drives the skip loading and No. 1 flight conveyor pumps. Adjusted chains on both bucket elevators. Bored three feet.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (F.T.)	
				Skip hoppers are not cleaning themselves. The muck leaves a heel everytime hopper is emptied. If not cleaned, the heel builds up to jam the hopper door in the open position. This throws the hoisting system out of sequence and shorts the skips. As a consequence a miner must physically prod and hose down the heel to keep the hopper clean.
22	0	622		Sunday, no scheduled work.
23	2	627		Experienced a malfunction in the safety system that automatically shuts down all the elctrically driven hydraulics when the skip hopper is full. Lost gripper pressure and dropped the BSB three inches. Reinstalled the fast retract propel check valves. The latest thinking is that their absence allows the shield to come down too fast thus causing the propel cylinders to suck air and become spongy. Adjusted and cleaned the interface between the flight conveyors and bucket elevators. Bored five feet.
24	2	629		Replaced the underground laser gun that failed after only 15 feet of boring. Replaced the failed Vickers No. 1 bucket elevator pump (that had no replacement) with the idle Sunstrand dewatering pump. Removed the steel frame that was used over the skip hoppers when dry boring. Reinstalled the No. 1 bucket elevator idler that came loose. Tightened No. 1 flight conveyor chain. Bored two feet. Had some rain today but the surface ponds are well stabilized and under control.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)
25	2	633	
26	2	634	

Automatic shutdown system that senses low lubrication and low gripper pressure and full hoppers has been continually shutting down the BSB by declutching the cutterhead drive motors. The spikes caused when reversing the flight conveyor motors (as much as six times per minute) may be the problem. If so, adding a condensor to the system will eliminate the cause.

Replacement laser gun has a different lens construction than the original and is more susceptible to dripping and splashing water.

Removed one-half link on No. 2 bucket elevator to compensate for wear.

Problems with both bucket elevators hanging up are continuing.

Bored four feet.

BSB is boring on top of a coal seam and generating boulders larger than the muck pickup system can handle. Requires shutting the BSB down and physically removing the wedged boulders from the pickup area.

Replaced the bypassed No. 2 bucket elevator pump.

Changed cartridge in the Vickers lubricating oil pump.

Tightened the leaking hydraulic hose between towers.

Added three drums of FR hydraulic fluid to replace that lost in changing pumps and leaking hose.

Increased bucket elevator speed.

Replaced loose bolts on No. 2 bucket elevator idler bracket.

Cleaned all Rexroth propel flow control valves.

Bored one foot.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
27	2	637		Boyce of Robbins chaired meeting of Cementation, Robbins, Battelle and WBEC. He reported that US Steel will require that boring cease 30 Jun 80, the BSB demobilized and the shaft completed by excavation. It was his intent that representatives of Robbins and the DOE meet with J.Y. O'Neil of US Steel on 3 Jul 80 and request an extension. They will attempt to convince J.Y. O'Neil that the BSB can bore at a rate comparable to that obtainable by shaft excavation. New scheduling was to repower the BSB during the week of 29 Jun 80. Bored three feet to complete 20-foot boring cycle. Last one-half foot was above a coal seam that generated boulders that had to be physically removed. Stripped, lowered and blocked all concrete forming rings. Lost considerable time stripping remaining forms because the high slump concrete worked its way into the crevices.
28	0	637		Saturday, no scheduled work.
29	0	637		Sunday, no scheduled work.
30	2	637		Since Cementation will only pour concrete on day shift, the pour was postponed until the following day. Cleaned the forms and welded all the crevices closed to minimize a repetition of the sticking problem. Extended slicklines and made preparations for pouring concrete. Propel cylinders relaxed immediately after the boring cycle causing the BSB to tilt and wedge against the wall. Spent remainder of day checking, cleaning and adjusting hydraulic system so that it would respond to the operators' controls.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

Time usage during the one-month reporting period

Hours

Availability to bore 144.5
Maintenance 231.5
Total Project Time 376.0

Actual boring 63.6

Pour concrete liner 28.5

Accomplishments

Feet

Total shaft bored 33
Total concrete liner poured 20

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	637	20	Poured 20 feet of concrete liner. Flushed concrete handling equipment and removed elephant trunks and remix pots. Washed cutterhead and pumped water from shaft. Checked cutters and determined that seven had to be replaced. Replaced Vickers No. 1 bucket elevator pump. Used Sunstrand idle dewatering pump available as a spare. Replaced cutters No. 13, 23, 25 and 48 and damaged helicoils. Installing west underground laser gun from the emergency hoist man cage.
2	2	637		Replaced cutters No. 22, 39 and 50. Retrofitted Vickers No. 1 bucket elevator with a new Rexroth pump in keeping with plan to repower the entire mechanical muck pickup system. The Rexroth had wrong rotation so rotation of the 50 hp electric motor drive (and Vickers dual lubricating pump located on the opposite shaft) will be reversed. Replaced Sunstrand idle dewatering pump that had just failed and will continue using it to temporarily power the No. 1 bucket elevator system. Changed all hydraulic and lubricating oil filters. Stripped concrete forming rings from the concrete liner. Adjusted laser beams.
3	2	637		Schmidt (DOE), Noga (DOE procurement) and Robbins (Robbins) met with O'Neil (US Steel) to get approval to continue boring shaft at a proposed rate at least equal to the rate achievable by excavation. O'Neil would not extend the 1 July 1980 deadline.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Day shift miners were advised of the decision at noontime and the night shift at the beginning of their shift.
				Extended all service and ventilation lines 20 feet.
				Cleaned skips and collar of shaft.
4	0	637		Holiday, no scheduled work.
5	0	637		Saturday, no scheduled work.
6	0	637		Sunday, no scheduled work.
7	2	637		This was the first day of work after Cementation had been unofficially told to stop boring and demobilize the BSB so that the shaft could be finished by excavation. It was determined that the BSB would have to bore an additional eight feet so that during disassembly, there would be sufficient room to lift the rear shield up to the concrete liner and into the center of the shaft. Inspected hoists as required by codes. Washed down the galloway. Cleaned concrete from the rings and forms. Pumped water from the shaft. Repaired short in underground laser in preparation to bore. Made inventory of tools required for galloway and BSB disassembly.
8	2	643		Spent almost one shift attempting to start BSB. Problems included moisture that worked into the lasers, the cutterhead drive motor potheads, the 50 hp electric motor that drives No. 1 bucket elevator and the Vickers dual lubrication pumps.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
9	2	645		Replaced worn No. 1 bucket elevator idler sprocket. Continually cleaned water splatter off east laser gun lens. Bored six feet. Rasmussen (Battelle) representing Robbins arrived on jobsite to coordinate demobilization. WBEC monitored this preliminary meeting in which the overall objectives of demobilization were discussed. Rebolted No. 1 bucket elevator idler sprocket. Replaced hydraulic hose on high pressure gripper system. Freed skip hopper doors that continually plugged. Bored two feet to give the required eight feet. Started cleaning shaft from collar down. Protopapas (Fuel & Minerals Resources, Inc.) visited site and shaft.
10	2	645		Removed and hoisted to surface both bucket elevator covers, drives and No. 2 bucket elevator chain with attached buckets. Cleaned and washed BSB. Removed surface backstop that prevented the muck from falling down the shaft and concrete hoppers that fed the slicklines. WBEC prepared a mothballing plan coordinated with demobilization to minimize duplication of efforts and save both time and money.
11	2	645		Cementation was officially told to stop boring and demobilize the BSB. Removing monitoring equipment from BSB.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Removed skip chutes with braces and skips. Started unbolting skip dumping structure attached to front legs of headframe.
12	2	645		Saturday. Completed unbolting skip dumping structure for removal as one piece. Rewound wire rope on man cage drum to eliminate slack in the second layer. Oiled, resocketed and tested the wire rope under load. Remarked drum for the new work locations in the shaft.
13	0			Sunday, no scheduled work.
14	2			Steel City used the same crane brought in to dig No. 1 pond to lift the 40-foot x 30-foot x 10-foot steel skip dumping structure in one piece from the north side of the headframe and lay it on the ground for later disassembly. The crane operator bent the 20-foot protruding legs when he rotated the structure from a vertical to horizontal position. Removal now gives 360° access to the shaft collar. Removed and hoisted No. 1 bucket elevator chain with attached buckets. Buckets were worn indicating that they were digging. Chain was 25 percent worn.
15	2	645		The trough installed between towers to prevent muck from falling from the carousel onto the top of the bull gear and main bearing seal was cut out. Removed ventilation tubing between BSB swivel and hard ventilation pipe attached to the shaft walls. Removed hydraulic hoses within the towers. Removed ventilation and dust suppression spray pipes, exhaust fan, ventilation bends and support structures from the west side of the headframe. Henceforth, fresh air will be forced into the face with the 36-inch fan and pipe.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
16	2	645		Cribbed under skip dumping structure and burned off damaged legs. Constructed concrete weights for prestressing skip cable guides after they are disconnected from BSB. Disconnected electric power to the shaft. The shaft water now will be pumped with an air driven, high pressure, low volume pump. Pumped lubrication oil into drums and hoisted them to surface. Cleared lubrication lines and cleaned top of bull gear and main bearing seal. Removed brackets fastening hoses in the towers so that the swivel and hoses can be removed and hoisted as one assembly. Started removing bolts on gripper ring. Extended service lines and added 30 feet of 36-inch discharge ventilation pipe so that welding fumes will be swept away and up from the face. Disconnected ventilation tubing to the transformer.
17	2	645		Burning off clips to disconnect the sheaves that attach the skip rope guides to the BSB. Fumes still a problem. Added 20 feet more of 36-inch ventilation pipe and one length of 30-inch flex tubing to bring the air directly above miners. Pumped FR hydraulic fluid into drums and hoisted them to the surface. Removed and capped hydraulic hoses to operator's console. Cleaned and hoisted debris and scrap iron to surface.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
18	2	645		Removed electric cables from the shaft collar to the galloway. Disconnected umbilical cables from galloway to BSB. Hoisted both skip rope guides with sheaves to surface. Burning shaft cover free so that it can be moved aside to disassemble galloway when hoisted to the collar. Removed both laser guns from their underground mountings. Hoisted galloway to collar of shaft.
19	0			Saturday, no scheduled work.
20	0			Sunday, no scheduled work.
21	2			Chaired (anchored) the galloway to the subcollar to take the weight off the wire rope. Spooled the wire rope on the hoist drums. Removed remaining electric cables from shaft. Removed piping above shaft cover to minimize any interference with galloway disassembly. Picked up and slid the shaft cover to the concrete pad to expose the shaft and galloway. Installed temporary fence around opening and removed subcollar steel. Started disassembly of BSB.
22	2	645		Covered unused 30-inch suction ventilation pipe for safety reasons. Removed top galloway deck in one piece and 7200 volt transformer. Removed form air tuggers, concrete hoppers with elephant trunks and top deck support.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
23	2	645		Working on shaft cover to replace both skip doors with one large door to pass larger components removed from the BSB. Since the man cage guide ropes that are a part of the galloway support were removed, they have to be re-activated so that the man cage can be used to transport miners to the BSB. After the galloway is removed from the shaft, both man cage rope guides will be lowered to the top of the BSB with each rope weighted down with a 55-gallon drum full of concrete and bolted to the BSB. Continue working on shaft cover and galloway.
24	2			Removed the remaining two galloway decks and covered the shaft with the modified shaft cover. Repaired inoperative air operated man cage door. Lowered and fastened the man cage guide ropes and gained access to the bottom of the shaft. Lowered electric and communication lines to provide lighting and bell/telephone communication with surface.
25	2	645		With the shaft cover in place, miners can work on the BSB. Installed interlocks on the shaft covers so that the hoist will pass man and/or material through the shaft cover only when the doors are open. Welded clips on grippers and shields to hold them in place after the bolts are removed. Removed hydraulic hoses and capped ends of fittings and valves. Removed and hoisted BSB No. 4 skip deck and man cage tubes, cable saddle, 30-inch tee from suction pipe and ventilation/hydraulic swivel. Stripped and hoisted top 10 feet of form to surface. Dewatered shaft.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
26	0	645		Saturday, no scheduled work.
27	0			Sunday, no scheduled work.
28	2			Work is on target as per schedule Rasmussen (Battelle) prepared at the beginning of mobilization. Stripped and hoisted nine sections of concrete form (48 make form 10 feet high). Removed and hoisted No. 4 (top deck, stage separation switch, skip tubes, mancage guides and miscellaneous fabrications between No. 3 and 4 decks. Removed pins from gripper ring cylinders. Covered openings so miners can not fall through.
29	2			Stripped and hoisted nine sections of concrete form. Removed and hoisted No. 3 deck, skip tubes and mancage guides, miscellaneous fabrications between No. 2 and 3 decks and skip hoisting control panel. Lowered and anchored mancage guide rope anchors.
30	2			Stripped and hoisted balance of concrete forms and floating ring. Removed and hoisted both skip hoppers and supporting fabrications, Aldrich (clear water) pump and all miscellaneous support fabrications between No. 2 and 3 decks. Removed and hoisted hydraulic hoses as they become available. Pumped shaft for second time since start of demobilization.
31	2	645		Removed and hoisted No. 2 deck, one skip tube, both skip hopper chute bottoms with cylinders mounted in their frames, operator console, miscellaneous fabrication hardware between decks, four geograph boxes and various electrical wires.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

DATE
SHIFTS WORKED
DEPTH, FEET
CONCRETE POURED
(FT.)

Hoses are badly abraided and should be discarded.

Performed surface housekeeping.

PROJECT LOG BOOK

August, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	2	645		Removed and hoisted inner and outer towers. All components are stripped down to the operator deck.
2	0			Saturday, no scheduled work.
3	0			Sunday, no scheduled work.
4	2			Removed and hoisted part of operator deck No. 4 cutterhead drive motor assembly, and 50 hp electric motor with attached Sunstrand No. 2 flight conveyor and Vickers skip loading pumps. Removed overhead air hoist monorail. Dewatered shaft.
5	2			Removed and hoisted balance of operator deck, No. 2 hydraulic tank with attached 50 hp electric motor driving the Rexroth No. 1 flight conveyor and Vickers skip loading pumps, lubrication tank with attached hydraulic motors and lubrication pumps, No. 5 and No. 6 cutterhead drive motor assemblies and miscellaneous parts. Miners no longer have any overhead cover and will have to be removed from the shaft whenever parts are hoisted.
6	2			Removed and hoisted No. 1, 2 and 3 cutterhead drive motor assemblies, No. 1 hydraulic tank with attached 50 hp electric motor, Vickers skip loading and Rexroth No. 1 flight conveyor pumps, three gripper cylinders, miscellaneous electrical and hydraulic hoses and lines and outer tower that extended from machinery to operator decks.
7	2			Removed and hoisted miscellaneous parts from the BSB and two gripper cylinders. No work being done to cake the remaining 1/3 flocculant in No. 1 pond.
8	2	645		Removed and hoisted all nine propel cylinders and some of the machinery deck parts.

PROJECT LOG BOOK

August, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				In order to pass the three-piece rear shield through the shaft cover, the cover was cut in half, from one side of the headframe to the other and the supporting I-beams were cut in half and bridged to conform with the shaft cover.
9	0	645		Saturday, no scheduled work.
10	0			Sunday, no scheduled work.
11	2			Preparation is being made to hoist the three-piece sections of rear shield using the two galloway winches, each with a two-part line and a horizontal spacer to maintain fleet angle on the drums. Completed modifying the shaft cover and collar. Disassembled skip dumping portion of headframe previously removed.
12	1			All men have been transferred to day shift. Henceforth, all work will be on one shift. Spent the entire shift hoisting and landing one section of the rear shield out of the shaft and onto the strip north of the headframe.
13	1			Hoisted remaining two sections of rear shield out of the shaft. Modified cable winder in preparation to spool the cable on reels. Replaced worn wheel assembly on No. 1 fan.
14	1			Started disassembly of inner shield, which includes burning off rusted and inaccessible bolts. Replaced worn wheel assembly on No. 2 fan. Completed disassembly skip dumping portion of headframe.
15	1	645		Continued disassembly of front shield.

PROJECT LOG BOOK

August, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
				Hoisted one of six front shield segments to surface. Started disassembling galloway. Started spooling electric cable on reels.
16	0	645		Saturday, no scheduled work.
17	0			Sunday, no scheduled work.
18	1			Hoisted two of the remaining five sections to surface in five hours. Continued disassembly of galloway. Making preparations to spool 7200-volt cable on reel.
19	1			Hoisted two of the remaining three sections of front shield. Cleaned site. Stacked galloway components near No. 4 muck pond.
20	1			Hoisted last section of shield from shaft. Spooled 7200-volt electric cable on reel. Making preparations to remove cutterhead support assembly.
21	1			Dewatered shaft for accessibility to the lower bolts. Hoisted the cutterhead support and main bearing as one assembly to surface. Disconnected all power, telephones and plumbing to all trailers except the Cementation trailer.
22	1	645		Cleaning cutterhead to gain access to the bolts. Dewatered shaft. Started disassembly of outriggers from the center section of the cutterhead.

PROJECT LOG BOOK

August, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
23	0	645		Saturday, no scheduled work.
24	0			Sunday, no scheduled work.
25	1			Continued disassembly of outriggers from center section of the cutterhead.
26	1			Hoisted the outriggers and center section. Used 90-ton and 60-ton cranes to lift the components away from the collar. Preliminary inspection indicates considerable wear of the removable scrapers and little, if any, wear of the four-inch replacement fixed scrapers. Pumped No. 3 pond supernatant into the main stream.
27	1			The 150-ton crane arrived. It will be used to turn over and move the center cutterhead section into a storage area. Continued disassembly of the galloway. Pumped No. 2 pond supernatant into the main stream. Breeched No. 2 dam so that rain water will not collect.
28	1			Cowin was awarded contract to complete the shaft by excavation and required that the 30-inch exhaust, two, six-inch slicklines and one, four-inch water discharge line be removed. Cementation put one galloway deck back into the shaft and started removing the lines from the top to bottom. Cleaned fans prior to shipment to Tucson.
29	1			Removed and hoisted 160 shaft-feet of all pipe. Cleaned site. Work force was down to six miners and six Cementation people.
30	0			Saturday, no scheduled work.
31	0	645		Sunday, no scheduled work.

PROJECT LOG BOOK

September, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	1	645		Labor Day, no scheduled work.
2	1			Removed and hoisted 180 feet of shaft piping. Cementation pumped No. 3 pond supernatant into main stream. Subcontractor began backfilling No. 6 site containing the caked solids. No. 2 pond is empty and ready to be backfilled.
3	1			Removed and hoisted 200 feet of shaft piping to complete all scheduled shaft pipe removal. Subcontractor continued to backfill No. 6 site. Cementation emptied No. 3 pond.
4	1			Removed galloway platform and welding cables. Replaced shaft cover and welded structural supports in place. Spooled east guide rope. Completed backfilling No. 6 site and started on No. 3.
5	1			Spooled west guide rope. Continued backfilling No. 3 pond.
6	0			Saturday, no scheduled work.
7	0			Sunday, no scheduled work.
8	1	645		Spooled west skip and mancage ropes. Removed east skip sheave and both rope tensioning beams from the top of the headframe. Continued to backfill No. 3 pond in low lifts to absorb the soupy fines.

PROJECT LOG BOOK

September, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
9	1	645		Removed west skip sheave from top of headframe. Started unbolting headframe.
10	1			Started removing siding from hoist house.
11	1			Removed emergency hoist from collar of shaft. Spooled all electric cables on reels. Completed removing siding from hoist house.
12	1			Removed hoist house roof.
13	0			Saturday, no scheduled work.
14	0			Sunday, no scheduled work.
15	1			Removed crown deck and backlegs with secondary platform.
16	1			Removed, laid down and started disassembly of the vertical section of the headframe. Paul Sands arrived on the site.
17	1			Completed disassembly and stacking of headframe. Removed hoist house structures. Hoists will be lifted directly off foundations onto trucks. Started backfilling No. 3 pond after the slimes dried.
18	1			Relocated the headframe components inside the security fence. Continued to backfill No. 3 pond.
19	1			Disconnected all electrical components. Continued backfilling No. 3 pond.
20	0			Saturday, no scheduled work.
21	0	645		Sunday, no scheduled work.

PROJECT LOG BOOK

September, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
22	1	645		Prepared the tool room, shops and compressors for shipment. Steam cleaned scrolls and skip dumping equipment. Continued to backfill No. 3 pond.
23	1			Loaded two trailers with Cementation owned equipment. Afternoon rain precluded any additional loading.
24	1			Unbolted all the hoists from the foundations. Rain prevented loading on trailers. Ponds No. 1, 2 and 3 have accumulated considerable water.
25	1			Loaded two trailers; interrupted by rain. Prepared remainder of equipment for loading. Rain turned all the remaining settling ponds into a swamp.
26	1			Loaded three trailers of equipment bound for Tuscon.
27	0			Saturday, no scheduled work.
28	0			Sunday, no scheduled work.
29	1			Loaded two trailers. Disassembled and stored galloway inside security fence.
30	1	645		Loaded two trailers.

PROJECT LOG BOOK

October, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)	
1	1	645		Shipped the fines-thickening plant on two trailers. Chipped out headframe backleg foundations. Steam cleaned and stored the skips, sinking bucket and chutes inside the security fence.
2	1			Loaded and shipped the skip hoist motor and all controls. Continued to backfill No. 3 pond.
3	1			Loaded and shipped the skip drums assembly.
4	0			Saturday, no scheduled work.
5	0			Sunday, no scheduled work.
6	1			Loaded and shipped skip hoist electrical panels and safeties. Advised miners that Friday, 10 Oct 80, would be the last work day.
7	1			Loaded and shipped emergency generator. Covered all the slimes in No. 3 pond. Started grading.
8	1			Loaded and shipped water truck, dry lockers and miscellaneous items. Wrapped the hoist rope on reels with protective burlap wrapping. Extended east fence line to encompass all the DOE owned equipment.
9	1			Performed miscellaneous work.
10	1	645		Performed miscellaneous work. Terminated all hourly employees.

PROJECT LOG BOOK

October, 1980

DAILY ACTIVITIES

DATE	SHIFTS WORKED	DEPTH, FEET	CONCRETE POURED (FT.)
11 to 15	645		

All the DOE owned equipment is now stored within a six-foot cyclone fence and secured by Pinkerton guards.

All the subcontractors, except Cementation, have left the site. Robbins retained Cementation to mothball and ship the stored equipment to the designated storage area.

Williams Brothers Engineering Company closed their field office 15 Oct 80 and personnel returned to the home office in Tulsa.

RADMARK VACUUM PICKUP TEST
Seattle, Washington

DATE	PERFORMANCE								
	DAILY					CUMULATIVE			
	Tons Lifted	Time Hr, Min	Rate TPH	Blower RPM	Vacuum in. Hg	Tons Lifted	Time Hr, Min	Rate TPH	
6-2-80	1.3	0:02	39	1800		1	0:02	30	
6-4-80	20.7	0:14	90	1700		22	0:16	82	
6-9-80	17.4	0:14	73	1800		39	0:30	78	
6-10-80	3.3	0:03	66	1800		43	0:33	78	
6-19-80	13.4	0:08	100	2000		56	0:41	82	
6-23-80	27.5	0:18	92	2000		84	0:59	85	
6-26-80	Water	Test				*			
6-27-80	Water	Test				*			
6-30-80	118.2	0:46	154	2200		202	1:45	115	
7-1-80	132.6	1:05	122	2200		334	2:50	118	
7-2-80	60.9	0:29	126	2200		395	3:19	119	
11-12-80	200	1:45	114	2100	12	200	1:45	114	
11-18-80	40	0:24	100	2000	10	240	2:09	112	
11-19-80	64	0:22	175	2000	12	304	2:31	121	
11-20-80	316	1:45	180	2000	13	620	4:16	145	
12-3-80	368	2:50	130	2000	12	988	7:06	139	
12-4-80	612	3:48	161	2100	13-14	1600	10:54	147	
12-5-80	330	1:54	174	2100	14-15	1930	12:48	151	
12-9-80	Water	Test				*			
12-10-80	Water	Test				*			
12-12-80	700	4:08	170	2050	13-14	2630	16:56	155	
12-16-80	756	4:02	187	2050	14-15	3386	20:58	161	
12-18-80	1004	6:12	162	2050	13-14	4390	27:10	162	
1-7-81	139	0:49	170	2000	13-15	4529	27:59	162	
1-8-81	120	0:48	150	2000	11-16	4649	28:47	162	
1-12-81	11	0:08	82	2000	6-8	* 4660	28:55	161	
1-12-81	140	0:46	183	2100	12-15	* 4800	29:41	162	
1-13-81	170	1:07	152	2100	10-16	4970	30:48	161	
1-14-81	113	0:43	158	2100	11-13	* 5083	31:31	161	
1-14-81	16	0:11	158	2100	6-9	* 5099	31:42	161	
1-15-81	Water	Test				*			
1-16-81	14	0:11	76	2000	12-14	* 5113	31:53	160	
1-20-81	46	0:15	184	2000	12-14	5159	32:08	161	
1-27-81	218	1:23	158	2100	12-14	5377	33:31	160	
First Test, BSB Retrofit Design, V-belt Blower Drive						395	3:19	119	
Second Test, BSB Retrofit Design, HTD Blower Drive						5377	33:31	160	
Overall Test Results, BSB Retrofit Design						5772	36:50	157	

*See Project Log Book for Details

PROJECT LOG BOOK

May, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)	
28	-	-	Robert Morse (WBEC) arrived on site and discussed test plans with Ken Ruby of Radmark Engineering. Completed setup of new diesel and started it for first time. One battery was stolen so both diesels will be started using one battery. Cleaned the blowers internally of debris caused by the fabrication of the new pipe system above them.
29	-	-	Continued working on installation of the V-belt drives on the four blowers. Connected the blowers into the pipe system. Tightened anchor bolts for hydraulic motor powering the W-300 rotary feeder. Installed inspection door above rotary feeder. Positioned 500-gallon water supply tank. Installed additional scraper on test fixture.
30	-	0:03	Hydraulic pump for bowl rotation not functioning properly. Small portion of conveyor discharge rebounds out of the bowl. Wooden deflector temporarily corrected the rebound problem. A combination deflector and bowl cleaning chute will be designed to eliminate hand shoveling to clean bowl.
31	-	-	Saturday, no work scheduled.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
1	-	-	Sunday, no work scheduled.
2	1.3	0:02	Problems with hydraulic pump for bowl rotation continued. Muck falls from conveyor prior to passing over weigh section of conveyor. Muck remains at outer edge of bowl and will require two additional scrapers. The telescoping joint above the pickup head is binding and limiting travel. Adjusted compensator on one hydraulic pump driving rotary feeder. Blower drive belt slippage is a problem and one belt tensioner needs relocated. Air velocity is insufficient to lift rock if blowers are running below 1600 rpm.
3	-	-	Replaced tachometer on new diesel with correct unit. Corrected blower belt tensioner. Hydraulic pump taken in for repair will be ready Thursday. Water pump for pickup head water nozzles is ready except for electrical hook-up. Bob Moffat of Robbins recommended two additional scrapers be added to more nearly simulate vacuum retrofit plans for BSB.
4	20.7	0:14	Completed installation of additional scrapers. Installed deflector plate on 45° angle at bottom of rock return pipe to reduce rebound off conveyor. Completed electrical connections on the water pump, allowing water addition at the pickup head.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
			Encountered problems with the spare pump for bowl rotation.
			Bob Moffat visited the site and concurred that the outside scraper immediately in front of the pickup head should be removed.
5	-	-	Replaced hydraulic pump for bowl rotation with rebuilt unit and set volume to turn the bowl at two rpm.
			The removed pump will be repaired thereby providing a spare for future service.
			Hydraulic pump powering telescopic joint failed. Rather than replace the pump, the bowl drive circuit was tapped to provide power for the telescopic joint.
6	-	-	Added a moveable chute at the conveyor discharge to either return the rock to the bowl or discharge the rock outside the bowl.
			Added additional scrap conveyor belting to rock return chute to reduce spillage from conveyor belt prior to weigh section.
			Dried and sealed electrical connections for conveyor scale sensing units.
			Conveyor scale calibration continues to be an area of concern.
7	-	-	Saturday, no work scheduled.
8	-	-	Sunday, no work scheduled.
9	17.4	0:14	Removed excess water from bowl by operating blowers at 1000 rpm.
			Made short test run but back flap on pickup head was held up resulting in a low tonnage rate.

PROJECT LOG BOOK

June, 1980

DATE
MATERIALS LIFTED
(TONS)
TIME
(HOURS, MINUTES)

DAILY ACTIVITIES

VACUUM PICKUP TEST

			Test terminated due to poor condition of material (some rock in a heavy mud slurry).
			Cleaned bowl and refilled with fresh 2-1/2 inch rock.
10	3.3	0:03	Checked conveyor calibration and adjusted slightly to bring counter (200 lb. units) and tonnage meter (0-300 tph) into agreement at 270 tph.
			Blower speed of 1700 rpm is insufficient to prevent rock from jamming in the pickup head.
			Blower speed of 1800 rpm is sufficient to lift 110 tph of material.
			Feeder jammed due to lifting rock before starting feeder.
			Feeder jammed because of sticky material building up in pockets.
11	-	-	Cleaned pockets on rotary feeder.
			Emerson Diesel adjusted no-load rpm on new diesel so both units will reach 2200 rpm.
			Removed inner pipe from telescopic joint and sent to machine shop to reduce O.D. by 1/16-inch and to taper upper end inward.
			Provided for introduction of air or water between inner and outer pipes of telescoping joint.
12	-	-	Cleaned water tank and repaired suction hose foot valve.
			Installed new work deck and safety rail at the rotary feeder.
			Lubricated all bearings and checked diesel and blower oil levels.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)	
13	-	-	Contacted several companies in search of interfaces necessary to use a stripchart to record blower rpm, vacuum as inches of Hg at the blowers, and tonnage being handled. Installed inner pipe of pickup head after some additional rework.
14	-	-	Saturday, no scheduled work.
15	-	-	Sunday, no scheduled work.
16	-	-	Increased rotary feeder speed to 45 rpm. Contacted Auto-weigh concerning several conveyor scale problems. Bob Moffat (Robbins Co.) recommended using 3.2 rpm for bowl rotation to simulate top speed of BSB which is necessary for high penetration rates. Bowl speed adjusted to 3.2 rpm.
17	-	-	Began relocation of rock return pipe to increase distance from conveyor load point to weigh idler. Emerson's mechanic adjusted governor on new diesel to better maintain the desired speed at the higher engine loads. Received cost estimate for installing safety shut-downs (low oil pressure, high water temperature, or engine overspeed) on diesel engines.
18	-	-	Continued work on relocation of the rock return pipe. Adjusted idlers on weigh conveyor so they are in one horizontal plane. The weigh idler is now 1/32-inch above the other idlers.
19	13.4	0:08	Completed relocation of rock return pipe.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
20	-	-	Recalibrated conveyor scale at rate of 135 tph. Weight of timed conveyor diacharge is within two percent of conveyor scale reading. Older diesel again having fuel supply problems. Installed four additional taps for measuring vacuum level throughout the system. Emerson Diesel began installation of safety shut-down equipment on engines. Added second conveyor scraper to minimize mud sticking on belt.
21	-	-	Saturday, no work scheduled.
22	-	-	Sunday, no work scheduled.
23	27.5	0:18	Completed installation of safety equipment on diesels and adjusted governors under the higher system load. Diesels now producing maximum power for present N 65 injectors. Injectors in both diesels will be changed to N 75's to increase the power output. Ordered components necessary for recording test data. Rented a six-channel recorder with delivery scheduled next Monday. The rock in the bowl is worn and has a high percentage of fines and water.
24	-	-	Changed diesel injectors and hot tuned the engines. Diesels now capable of 14-1/2 inches of Hg at 2100 rpm. Inspected horizontal inlet to cyclone and removed considerable muck buildup. Rented a Bobcat for handling rock.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
25	-	-	Emptied bowl of all rock and mud. Filled bowl with water and ran blowers several minutes to flush system and clean out mud and rock buildups. Conveyor scale indicated an excess of 98 tph of water handled. Emptied bowl of water and fines.
26	-	-	Filled bowl with water and used the feeder to measure volume. More than 800 gallons per minute of water was lifted while operating at 2100 rpm with a vacuum of 12 inches Hg. Sefab relocated a heavy steel tank adjacent to the fixture, halting work today. Ordered a 500-gallon diesel fuel tank.
27	-	-	Modified system so that operations could be continued with the tank adjacent to test fixture. Conducted a second water test at 2200 rpm with 12 inches Hg. Lifted 1100 gpm. Rigid pickup head with variable throat arrived from Portland. New head apparently has two problems: 1. Variable throat is curved upward and will trap rock causing loss of movement. 2. Weight is 850 pounds. Broke weigh conveyor drive chain twice.
28	-	-	Saturday, no work scheduled.
29	-	-	Sunday, no work scheduled.

PROJECT LOG BOOK

June, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)	
30	118	0:46	Relocated 500-gallon water supply tank on top of the test fixture. Cleaned bowl and filled with fresh rock. Made six test runs totaling 46 minutes. Encountered problems with blower drive belt slippage and drive belt tensioners. Added breaker bar on bottom of pickup head to help break rock loose from bowl.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
1	133	1:05	Placed additional rock in bowl. Started a test run but shutdown after five minutes because of blower drive belt slippage. Tightened drive belts then idled system to cool belts. Resumed testing but after 19 minutes, belt slippage forced a system shutdown. The belts and pulley sheaves were cooled with water, belts tightened and belt dressing applied. Terminated a third run after 35 minutes because of belt slippage. The afternoon was divided between testing and cooling the inadequately sized blower drive belts.
2	61	0:29	Demonstration run was made for: Dale Durrett - Skelly and Loy Dr. Tako Protopapas - Fuel and Mineral Resources Terminated the demonstration run due to slippage of the blower drive belts.
3	-	-	Removed V-belt blower drive system in preparation for upgrading to handle increased loads. Investigated alternative power transmission methods and obtained two quotes on more adequate systems. Radmark terminated testing at noon because contract test funds were exhausted. Cancelled fuel tank order. Returned data recorder.
4	-	-	Holiday, no work scheduled, site shut down.
5	-	-	Saturday, no work scheduled, site shut down.
6	-	-	Sunday, no work scheduled, site shut down.

PROJECT LOG BOOK

July, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

7
to
25

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Utilized the three-week period from July 7, 1980 to July 25, 1980, to plan modifications to the test system.

The physical modifications were directed toward making the operation of the system more continuous and less of a batch process. This was to:

1. allow more testing in a given amount of time
2. more closely simulate expected mode of operation on a shaft boring machine
3. provide better control over the condition of the material being lifted
4. facilitate progress by eliminating the cleaning of the bowl with shovels.

Prepared drawings for a new conveyor discharge chute with provision for inserting screens with different size openings. This will permit continuous discharge of fines and water while retaining the coarser material in the bowl. Also prepared drawings for a chute to add rock to the bowl and for brackets to hold the diesel rpm sensors.

A suitable blower drive system was selected. The combination of high shaft speeds, high horsepower, and working environment made several of the available options marginal. Selected a Uniroyal Powergrip High Torque Drive (HTD) system. The HTD belt is a synchronous drive and features no slip, light weight, high efficiency, low tension and minimal maintenance.

Made preparations for recording of test data.

Radmark scheduled no work from July 29, 1980 until October 21, 1980; therefore, Williams Brothers Engineering Company had no personnel at the vacuum pickup test site in Seattle during that period.

PROJECT LOG BOOK

October, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
21	-	-	Robert Morse (WBEC) arrived at test site and began arrangements for resumption of testing. Checked on new blower drive components. They had not arrived at Chain Gear Inc. Ken Ruby ordered new drives earlier to minimize delays in testing when site again became available.
22	-	-	Purchased lubricating oil for blowers, oil filters for the diesels and a new diesel battery. Restored power and telephone service to office trailer.
23	-	-	Purchased lubricating oil for diesels and checked on diesel fuel suppliers for the loan of a second tank to supplement the 200-gallon tank. Completed arrangements for personnel today. A helper will be available tomorrow and all of next week. Starting Monday, a shop mechanic from Sefab and a field service technician from the Robbins Company will be assigned to the test.
24	-	-	Made good progress on restoring the site to working order. Reviewed proposed test fixture modifications and inspected fixture for any needed improvements or repairs.
25	-	-	Saturday, no work scheduled.
26	-	-	Sunday, no work scheduled.
27	-	-	New blower drive components arrived and installation began. Changed lubrication oil in the diesels and started work on the rpm sensor brackets. Over the weekend the battery and alternator were stolen off the older diesel.

PROJECT LOG BOOK

October, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)	
28	-	-	New blower drive installation was delayed because both diesels must be moved 2 inches farther from their respective blowers. Ordered new jackshaft for one pair of blowers. Restored electrical power to the test fixture hydraulic power unit. Checkout of hydraulic components began. Ken Ruby and Robert Morse met with Mike Olwell of Sefab to finalize the working agreement for this new test period.
29	-	-	Blower drive installation nearly complete and belts track well. Rotary feeder and telescopic joint are functional. One bowl drive chain is worn and does not track properly and will jump off the sprocket if bowl started or stopped suddenly.
30	-	-	Brad Wolford (Uniroyal power transmission representative) inspected belt installation and assisted in making adjustments. System performance, checked by blocking off pickup head, is now 14 inches of Hg at 2100 rpm with no blower drive problems. Arranged for a source of rock. Concluded a purchase agreement with diesel fuel supplier.
31	-	-	Calibrated the conveyor scale. It is within 1 percent at full (270 tph) and half (135 tph) calibration loads. Conveyor discharge chute is 80 percent completed.

PROJECT LOG BOOK

November, 1980

DATE
MATERIALS LIFTED
(TONS)
TIME
(HOURS, MINUTES)

DAILY ACTIVITIES

VACUUM PICKUP TEST

1	-	-	Saturday, no work scheduled.
2	-	-	Sunday, no work scheduled.
3	-	-	Conveyor discharge chute completed. Two loads of 1½-inch crushed river rock delivered to site. Short shakedown run momentarily indicated a pickup rate of 180 tph but several problems need correcting. Repairs to system started. Six channel data recorder arrived.
4	-	-	Fifty tons of 3-inch crushed basalt delivered to site. Started testing but two scrapers broke and the rotary feeder jammed. Cleaned the feeder and increased its speed from 37 to 46 rpm. Replaced one essential scraper. Eric Powell and Ken Ruby were at site to review test plans. The six channel recorder will be used as follows: Event Marker 1 - Time for chart speed checks Event Marker 2 - Mark 200-pound units across conveyor scale Event Marker 3 - Remotely triggered for event identification Event Marker 4 - Spare Channel 1 - Diesel 1 rpm (north unit) Channel 2 - Diesel 2 rpm (south unit)

PROJECT LOG BOOK

November, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)	
			Channel 3 - Conveyor Scale (instantaneous tons per hour)
			Channel 4 - Vacuum, inches of Hg (any location)
			Channel 5 - Vacuum, inches of Hg (any location)
			Channel 6 - Vacuum, inches of Hg (at blowers)
5	-	-	Obtained 300-gallon fuel tank to permit long runs and bulk fuel deliveries. Rental company exchanged new diesel powered Bobcat for old gas powered unit. Ordered two additional pressure transducers.
6	-	-	Rerouted three vacuum lines into office trailer. All possible data recording equipment will be kept inside the trailer. Blower belt drive guards were covered with one-inch rigid foam to provide better noise control.
7	-	-	Three recorder channels were operational (1, 2, & 6). A short run indicated over 200 tph (1 minute at 240) with water content ranging from six percent (sticky) to 20-30 percent (very soupy).
8	-	-	Saturday, no work scheduled.
9	-	-	Sunday, no work scheduled.
10	-	-	Channel three now operational for recording instantaneous tonnage rate of material handled. Increased rotary feeder to 50 rpm to reduce jamming. Terminated the short test runs at noon because of jackshaft bearing failure.

PROJECT LOG BOOK

November, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
11	-	-	Installed new jackshaft bearing. Adjusted and calibrated conveyor weigh scale. Modified conveyor discharge chute to allow timed discharges for checking conveyor scale.
12	200	1:45	Numerous problems with rotary feeder jamming. All four jackshaft bearings running warm but not dangerously hot as before. Modified conveyor discharge grate to improve control of rock size retained and the discharge of water and fines.
13	-	-	Connected hydraulic oil cooler to city water supply with the cooler discharge connected to the 500-gallon water tank. Ken Ruby brought a single-channel recorder from Portland. A rpm sensor circuit will be ordered to enable recording of rotary feeder rpm. Inspected horizontal run at cyclone inlet and found muck buildup. Started construction of walkway on framework above bowl for observer safety. The two new pressure transducers will require a amplifier circuit for usable output.
14	-	-	Constructed sump to contain water and fines discharged from the bowl during tests. Cleaned horizontal inlet to cyclone. Constructed combination work bench and recorder table in office trailer. Ordered components to measure rotary feeder rpm.
15	-	-	Saturday, no work scheduled.

PROJECT LOG BOOK

November, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
16	-	-	Sunday, no work scheduled.
17	-	-	Cleaned and dewatered bowl. Modified containment skirt on rock return chute to eliminate spillage from conveyor belt. After a short run, the rotary feeder jammed due to a packed pocket. Cleaned feeder and resumed test. Bowl drive sprocket came off hydraulic motor shaft. A new bushing will be required to resume operation.
18	40	0:24	Replaced bowl drive sprocket and retensioned bowl drive chains. Constructed walkway over weigh conveyor. Replaced scraper that was broken off during today's test. A broken throttle cable on one diesel terminated testing for the day.
19	64	0:22	Modified throttle cables on both diesels. Enlarged discharge sump. Increased rotary feeder speed to 59 rpm. Paul Sands, USBM, arrived at test site.
20	316	1:45	Calibrated conveyor scale and data recorder. Two visitors from Thyssen Schachtbau visited site and observed system in operation. Attempted to make transition from wet to dry operating mode and plugged all feeder pockets with sticky material. Experienced minor feeder jams while running wet but quick feeder reversal corrected problem.

PROJECT LOG BOOK

November, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
21	-	-	Found and corrected problem with diesel rpm recording circuits. Ken Ruby (Radmark), Paul Sands (USBM) and Robert Morse (WBEC) reviewed test data and formulated new test plan. New test plan calls for simulating a 20-foot borer cycle. Test objective is to lift 900-1000 tons in six to seven hours (one actual shift).
22	-	-	Saturday, no work scheduled.
23	-	-	Sunday, no work scheduled.
24	-	-	Began modifications necessary to make long test runs. Installed rock supply bin above bowl to insure sufficient rock in bowl at all times. Located a second diesel fuel tank which can be borrowed.
25	-	-	Installed additional guard rails on rotary feeder work deck. Set up containment for material discharged from bowl. Started installation of rotary feeder rpm sensor.
26	-	-	Rotary feeder rpm sensor ready for calibration. Brought 275-gallon diesel fuel tank to site. This increases fuel supply to 750 gallons. Purchased new fuel lines and selector valves to connect one auxiliary fuel tank to each engine.
27	-	-	Holiday

PROJECT LOG BOOK

November, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)
28	-	-
29	-	-
30	-	-

Holiday

Saturday, no work scheduled.

Sunday, no work scheduled.

PROJECT LOG BOOK

December, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
1	-	-	Constructed large sump and drainage ditch. Replacement recorder arrived in poor condition so cannibalized it to repair old recorder.
2	-	-	Connected hydraulics to control discharge of new rock bin. Repositioned weigh conveyor tail pulley to center of conveyor rails. The data recorder is again 100 percent operational.
3	368	2:50	Completed repairs to weigh conveyor. Calibrated conveyor scale and data recorder. Repaired broken scraper and replaced one bowl support wheel. A scrap of 2-inch x 6-inch wood in feed rock jammed the feeder.
4	612	3:48	Started new working hours of 7:30 am to 4:00 pm to make best use of available daylight. Broke and repaired two bowl scrapers. Filled rock supply bin and used during testing. Feeder problems minimal at higher rpm.
5	330	1:54	Second order of three-inch basalt was delivered to site. Lubricated the entire system. Calibrated conveyor and data recorder. Selected flat wear plates for wear inspection next week.
6	-	-	Saturday, no work scheduled.
7	-	-	Sunday, no work scheduled.

PROJECT LOG BOOK

December, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

			PROJECT LOG BOOK															
			December, 1980															
DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	DAILY ACTIVITIES															
VACUUM PICKUP TEST																		
8	-	-	Repositioned two scrapers closer to bowl to reduce volume of material passing under the scraper. Positioned new rubber scraper at periphery of the bowl to reduce mud buildup. Prepared new conveyor discharge screen of woven wire screen with 3/8-inch openings and 54 percent overall open area.															
9	-	-	Inspected rotary feeder and adjusted side plates inward 5 to 6 thousandths of an inch. Conducted water test with mixed results: <table><tr><td>Blower, rpm</td><td>Inches of Hg</td><td>Water, gpm</td></tr><tr><td>2100</td><td>13</td><td>600</td></tr><tr><td>1800</td><td>12½</td><td>1100</td></tr></table>	Blower, rpm	Inches of Hg	Water, gpm	2100	13	600	1800	12½	1100						
Blower, rpm	Inches of Hg	Water, gpm																
2100	13	600																
1800	12½	1100																
10	-	-	Conducted test to determine systems resistance to airflow. At blower speeds of 1900 to 2100 rpm, vacuum ranged from 4.2 to 5.0 inches of Hg. Additional water lift test produced: <table><tr><td>Blower, rpm</td><td>Inches of Hg</td><td>Water, gpm</td></tr><tr><td>1000</td><td>11</td><td>1350</td></tr><tr><td>1200</td><td>11</td><td>1880</td></tr><tr><td>1100</td><td>12</td><td>3050</td></tr><tr><td>2100</td><td>13.4</td><td>3200</td></tr></table> Discovered hole worn through lower elbow in upcast pipe.	Blower, rpm	Inches of Hg	Water, gpm	1000	11	1350	1200	11	1880	1100	12	3050	2100	13.4	3200
Blower, rpm	Inches of Hg	Water, gpm																
1000	11	1350																
1200	11	1880																
1100	12	3050																
2100	13.4	3200																
11	-	-	Removed lower elbow and measured pipe thickness of 3/8-inch. System handled over 2500 tons of material to wear through a 3/8-inch mild steel elbow. (2500 ton represents approximately 55 feet of 24-foot, 5-inch shaft)															

PROJECT LOG BOOK

December, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
			Built up worn areas, in both lower elbows, with normal rod then applied a layer of wear resistant rod.
12	700	4:08	Repair and installation of the elbows were completed by mid-morning. Rotary feeder speed set at 60 rpm. Conveyor and recorder calibrated. Made a good run with minimal feeder problems.
13	-	-	Saturday, no work scheduled.
14	-	-	Sunday, no work scheduled.
15	-	-	Removed and measured wear on three of the flat plates on the rectangular upcast pipe. Worst wear was 1/8-inch for 3200 tons of material handled (equivalent to approximately 70 feet of shaft). Fabricated new cable connecting linkages for the diesel throttle cables. Removed coarse rock from the sump.
16	756	4:02	Filled rock supply bin and calibrated weigh conveyor and data recorder. Meter in conveyor scale box malfunctioned but recorder circuit continued to operate satisfactorily. Wore hole through rock return pipe.
17	-	-	Repaired rock return pipe. Modified two scrapers to produce a better furrow with less bypass. Changed oil in the gearbox on one blower.

PROJECT LOG BOOK

December, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
18	1004	6:12	Emerson Diesel inspected both diesels and confirmed that both are performing at maximum. Cleaned sump until 95 percent of the original capacity was restored. Lubricated the entire system. Calibrated conveyor scale and recorder. Handled enough rock to simulate a 20-foot borer cycle. Radmark took movie to document the operation of the system and the calibration of the conveyor. Downtime totaled eight minutes for today's test. Filled sump to overflowing with water and fines. Ken Ruby and Gary Nash of Radmark were at the site all day.
19	-	-	No additional long duration high tonnage tests are planned because of difficulties in disposing of waste rock. Ken Ruby concurred with this decision. Partially cleaned the sump so material is contained. Initiated conversion of system to instrument-only operation. Inspection of lower elbow indicates complete wear through is eminent. System has now handled 5000 tons.
20	-	-	Saturday, no work scheduled.
21	-	-	Sunday, no work scheduled.

PROJECT LOG BOOK

December, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
22	-	-	No work crew was available today because one man was sick and the other was on medical leave for surgery. Directed effort toward instrumentation necessary for blind operation. Started instrumentation material list and checked physical requirements.
23	-	-	No crew today. Completed instrumentation requirements. Cleaned sump of coarse material. Dewatered and cleaned bowl in preparation for inspecting scrapers and pickup head. Found scrap of 1/2-inch steel plate which evidently caused last Thursday's feeder jam.
24	-	-	Regular crew not available but Sefab maintenance man helped remove lower elbow and the first flat wear plate. Inspection of the flat wear plate indicated 1/4-inch wear so reversed it, end-to-end to shift wear to a new location.
25	-	-	Holiday
26	-	-	Holiday
27	-	-	Saturday, no work scheduled.
28	-	-	Sunday, no work scheduled.
29	-	-	No crew again today because Sefab was shut down. Reviewed instrumentation plan. Positioned plywood sheet to block operator's view of the test fixture. Built stable platform for operator's chair.

PROJECT LOG BOOK

December, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
30	-	-	Ken Ruby arrived on site. Repaired both mild steel elbows. Reinstalled both mild steel elbows reversing them end-for-end in their respective positions. Investigated circuitry that will provide adequate indication of diesel rpm.
31	-	-	Assembled and tested solid state circuit for diesel rpm indication. Installed cable for pickup head position indicator. Prepared box to hold tonnage meter for operator.

PROJECT LOG BOOK

January, 1981

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS , MINUTES)	
1	-	-	Holiday
2	-	-	Holiday
3	-	-	Saturday, no work scheduled.
4	-	-	Sunday, no work scheduled.
5	-	-	Installed two additional vacuum taps to further define system pressure drops. Continued setup of instrumentation for "blind" operation.
6	-	-	Cleaned site, gathered and moved all rock in barrels and scrap buckets to one accessible location. Instrumentation was installed.
7	139	0:49	Inspected blower drive belts and made minor adjustments to two of the four belts. Checked instrumentation. All were satisfactory with the exception of the diesel rpm detectors. Feeder jams can be induced by throwing short length of 4 x 4 (wood) into bowl.
8	120	0:48	Ken Ruby was at the test site to review instrument operation. Because of the postponement of the demonstration until the 27th of January, it was decided to exchange pickup heads. Pickup head change will be done so that the old head can be reinstalled easily if the new head does not perform satisfactorily. Removed the old pickup head and telescopic joint.
9	-	-	Installed a short pipe to lower the bottom elbows.

PROJECT LOG BOOK

January, 1981

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
			Pipe was cut to length to connect elbows to pickup head.
			Revised circuits for diesel rpm. They no longer interfere with data recorder.
10	-	-	Saturday, no work scheduled.
11	-	-	Sunday, no work scheduled.
12	11 140	0:08 0:46	Completed installation of new pickup head and made a short test run.
			Rock buildup within head jammed the moveable plate in the throat.
			Modified moveable plate and resumed testing.
13	170	1:07	Ken Ruby was on site to view performance of the new pickup head.
			Performance of the new head is satisfactory for demonstration purposes.
			Conducted moisture test to aid in determining percent of water being lifted in our testing to better analyze the test data.
			Check of the conveyor scale (by time and weight of material discharged) indicated it was low by almost 10 percent.
14	113	0:43	Removed fines from bowl and test fixture.
			Removed coarse material from sump.
			Conducted test to determine how height of the side skirts on the pickup head influence performance.
			Height has little effect on tonnage lifted. A height of one to two inches is best for cleaning the face.
			Opening both front and rear flaps does not totally stop pickup of the material.

PROJECT LOG BOOK

January, 1980

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
15	-	-	Pickup rate with front and rear flaps up is high. Material from barrels and scrap buckets is being dumped and sorted for possible testing. Water capacity test indicated: Blower rpm: 2000 Vacuum: 13.5 inches of Hg Water: 3580 gpm (890 tph) Diesel rpm indicated circuitry now sensitive enough to indicate within 50 rpm.
16	14	0:11	Conducted test using black silica slag (sandblasting sand). Vacuum alone unable to clean face of all sand. Data recorder blew two fuses due to intermittent stray signal. Source was not located.
17	-	-	Saturday, no work scheduled.
18	-	-	Sunday, no work scheduled.
19	-	-	Cleaned test site in preparation for demonstration. Reviewed plans for demonstration and subsequent work.
20	46	0:15	Continued site cleanup Made short test run using mixture of basalt and granite. Vacuum lifted several seven-pound firebricks (9 inches x 4.5 inches x 2.5 inches).
21	-	-	Conducted second moisture content test on sample containing a high percentage of fines. Free water occurred at 16 percent moisture by weight.

PROJECT LOG BOOK

January, 1981

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
22	-	-	Installed hydraulic cylinder to lift rear flap on pickup head. Investigated noise heard in rotary feeder at startup. One striker plate in feeder had broken free from anchor bolts. Called Ken Ruby for recommendation. No spare is available so existing plate will be mounted in a modified fashion.
23	-	-	Longer bolts were used with washers to remount striker plate. Tested repaired feeder and performance was satisfactory. Cleaned bowl, rock bin, and test fixture.
24	-	-	Saturday, no work scheduled.
25	-	-	Sunday, no work scheduled.
26	-	-	Made final site preparations for demonstration. Filled rock supply bin. Checked all instrumentation and data recorder operations.
27	218	1:23	Prepared equipment for demonstration. Calibrated weigh conveyor, pressure transducers, and data recorder. Visitors arrived and were given tour of site before demonstration. Began demonstration with minimum water addition. Broke hose that supplied water to pickup head nozzles.

PROJECT LOG BOOK

January, 1981

DAILY ACTIVITIES

VACUUM PICKUP TEST

DATE	MATERIALS LIFTED (TONS)	TIME (HOURS, MINUTES)	
28	-	-	Submerged 1/4 to 1/3 of the rock furrow in water for latter portion of the test. Began site demobilization after lunch. Removed blower drives and relocated both diesels and one pair of blowers into the high bay. Blower condition appears to be unchanged since the inspection of May, 1980. Disconnected all hydraulic hoses and electrical power.
29	-	-	Set second pair of blowers into high bay and again no visible lobe wear was indicated. Hauled off the waste material and backfilled the sump.
30	-	-	Removed wear plates from the rectangular pipe. Ken Ruby was on site to finalize demobilization plans. Checked the lobe clearances and gear play in all four blowers, no significant wear was noted. Initial blower clearances are not known but present measurements are satisfactory. Maximum wear is 0.003 on the lobes. Measurements on rectangular pipe wear plates indicate 3/8 inch of abrasion resistant steel will last for boring 200 feet of shaft. Robert Morse (WBEC) will leave the Seattle test site February 2.

PROJECT PROBLEMS

INTRODUCTION

The Project Problem section is a presentation of:

- o Actual problems observed during the BSB field trial
- o Potential problems that could arise on future projects
- o A modified BSB design
- o Guidelines for a conceptual redesign of the BSB

The primary objective of this Problem Book is to document BSB operational problems, the results of efforts to solve each problem, and to delineate potential problems so that the information can be used on future BSB projects.

The actual problems observed during the field trial were analyzed to identify the causes. Results of efforts made to solve the problems are noted. The discussion of each problem is followed by recommendations to eliminate the problem on future BSB's.

The potential problems are described and analyzed. Recommendations are given that will prevent them from arising on future BSB projects.

The major deficiencies of the existing BSB are corrected in the modified BSB design while utilizing the major structural members. This will provide a cost effective method of demonstrating that satisfactory penetration rates can be achieved. The modifications to the BSB are based on components proven in similar usage or tested under appropriate conditions.

The design of the modified BSB includes the recommendations that will improve the BSB sufficiently for a second field trial. The second field trial will provide information necessary for the design of an economically and commercially acceptable BSB. The modifications to the BSB for the second field trial concentrate on four areas:

- o cutterhead
- o muck pickup system
- o hydraulic system
- o lubrication system

The modified BSB will have faster penetration rates than the existing BSB and improved day-to-day operations.

The conceptual redesign of the BSB should address all the problem areas. It is probable that little if any of the existing BSB would be utilized. Recommendations and guidelines for a conceptual redesign of the BSB are presented at the end of this report.

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CUTTERHEAD

Problem 1 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Boring rates deteriorated from one to one-half foot per boring hour during the lift of the project.

CAUSE

Factory installed seven-inch high fixed scrapers that dozed the muck away from the bucket elevator wells had worn down to three and one-half inches. As a consequence, the bucket elevators had to dig in the accumulated muck on the face at the bottom of the well in addition to lifting muck from the flight conveyors to the skip hoppers.

INTERIM SOLUTIONS

Four-inch scrapers were added creating an additional furrow but this addition did not solve the problem. The idler sprockets were raised about 5 inches to get more clearance between the buckets and the face.

RECOMMENDATIONS

Replace the original cutterhead with a steep sided, self-cleaning cutterhead eliminating the need for fixed or replaceable scrapers.

CUTTERHEAD

Problem 2 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Tramp iron jammed and usually damaged the cutters and flight conveyor.

CAUSE

Sources of the iron included:

- o pieces broken from the structurally weak, one-inch thick removable scrapers,
- o removable scrapers that fell through the retaining slots,
- o flight conveyor parts dislodged from mountings.

INTERIM SOLUTIONS

The BSB was stopped immediately when the presence of iron was detected. Initial removal was attempted by rotating the cutterhead without any thrust pressure to allow the scrapers to divert the iron into the pickup area. If that failed, the iron was located then removed through the cutterhead openings, such as the bucket elevator wells or the spaces between the outriggers.

RECOMMENDATIONS

Replace the original cutterhead with an open face, steep sided, self-cleaning cutterhead with vacuum muck pickup. This would eliminate the sources of tramp iron, as experienced during the trial borings. Any other iron deposited on the face would be located and removed through the open face.

CUTTERHEAD

Problem 3 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Cutters stopped rotating causing the rings to develop flat spots. The failure was identified by a loss in boring performance, accompanied by both heat and smoke.

CAUSE

Cutter bearings failed or tramp iron wedged against one or more of the cutters.

INTERIM SOLUTIONS

Cutterhead was stopped, washed down and the failed cutters located. Because of the possibility that the failure could have been caused by tramp iron, an attempt always was made to locate iron when the cutter(s) were replaced.

RECOMMENDATIONS

- o Minimize bearing failures by rebuilding the cutters in a "clean" room using premium bearings and testing the rebuilt cutters.
- o Eliminate most of the sources of tramp iron by replacing the original cutterhead with a steep sided, self-cleaning cutterhead with vacuum muck pickup.

CUTTERHEAD

Problem 4 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Cutter replacement was excessive, more than 290 cutters were replaced during 600 feet of boring. This consumed about eight percent of the project time and cost.

CAUSE

Energy differential between the five-foot-per-hour boring capability of the cutterhead and the actual boring rate of one-half foot per hour was used in regrinding muck and subsequently reduced cutter footage life.

INTERIM SOLUTIONS

Hydraulic thrust pressure was reduced from 2000 to 800 psi. This lowered the pressure on the bearings but it did not reduce the amount of muck that contacted the cutters.

RECOMMENDATIONS

Replace the original cutterhead with a steep sided, self-cleaning cutterhead that will give the cutters a clean face to load. Replace the mechanical muck pickup system with a vacuum system that has the capacity to remove all the muck that the cutterhead produces.

CUTTERHEAD

Problem 5 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Boulders jammed the flight conveyors.

CAUSE

Boulders originated from the coal seam roofs. The coal seam roofs broke into large pieces then prestressed into the softer underlying coal.

INTERIM SOLUTIONS

The cutterhead was stopped as soon as boulder presence was suspected. The boulders were removed by hand and any detected damage was repaired. Boring was cautiously resumed and additional boulders removed as they formed until the cutting sizes returned to normal.

RECOMMENDATIONS

This would be an important design feature of the new cutterhead, especially if the BSB is to bore shafts in rock formations that are less massive and competent than those at the Alabama site. The replacement self-cleaning cutterhead should have cutters and/or roller bits that reduce the size of the cuttings that are fed into the vacuum pickup system.

CUTTERHEAD

Problem 6 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The stationary bottom pan under the flight conveyors had to be replaced after each 100 feet of boring.

CAUSE

Failures were caused by one or more of the following reasons:

- o Grippers lost pressure when the cutterhead was off the face allowing the entire weight of the BSB to impact the cutters and the flight conveyor pans.
- o The operator thrust the cutterhead into the face without rotation or bounced it on the face to free muckbound flight conveyors.
- o BSB bored into a soft material, such as coal, that allowed the cutters to bury themselves and transferred too much of the BSB weight to the flight conveyor pans.
- o Poor previous installation.

INTERIM SOLUTIONS

Operator was instructed to lower the cutterhead into the face only when rotating.

RECOMMENDATIONS

Replace the original cutterhead with a self-cleaning cutterhead with a floating vacuum muck pickup that would not be damaged with impact.

CUTTERHEAD

Problem 7 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Shaft face was always fully or partially covered with muck, forcing the cutters to regrind muck to reach virgin rock.

CAUSE

The nearly flat shape of the cutterhead required that scrapers doze muck into the pickup areas. Design of the scrapers did not permit continuous contact with the face so a layer of muck of varying thicknesses was always present on the face.

INTERIM SOLUTIONS

Removable scrapers were replaced periodically. A one-time addition was made to the fixed scrapers.

RECOMMENDATIONS

Replace the original cutterhead with a steep sided, self-cleaning cutterhead that uses gravity and possibly air and/or water jet assist to keep the face clean, thus eliminating the need for scrapers.

CUTTERHEAD

Problem 8 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Miners had considerable difficulty working in the cutterhead, which was accessible only through a trapdoor in the machinery deck.

CAUSE

The cutterhead was fabricated in four to five foot square cells, interconnected with cutouts, somewhat like a beehive. In those cells housing the flight conveyors, only one miner could work at any one time. These physical restraints were further compounded by dripping water and an air inflow of 15,000 cfm that represented a 10 to 15 mph wind velocity.

INTERIM SOLUTIONS

No solution was available for the limited work area or dripping water problems. In violation of MSHA regulations, the miners occasionally shut down the exhaust fan for short periods to reduce the windchill that became intolerable during the winter.

RECOMMENDATIONS

Replace the original cutter with an open face cutterhead in which the entire crew can work at the same time. Access would be through the wide center opening so that all replacement components, such as cutters could be lowered and swung into mounting position without double handling. The use of the vacuum muck pickup will eliminate need for the exhaust fan.

CUTTERHEAD

Problem 9 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Personnel could not work under the cutterhead.

CAUSE

Cutterhead was so designed that cutters could be replaced from within the cutterhead and the fixed scrapers were expected to last the life of the shaft; therefore, no provision was made for personnel to work under the cutterhead.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

The spaces in the cutterhead should be seven feet high so that miners or technicians can work comfortably.

The modified BSB with a steep sided, self-cleaning open face cutterhead would not require men to work under it. All work could be accomplished by working between the cutterhead arms.

CUTTERHEAD

Problem 10 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Cutters were difficult to change from within the cutterhead.

CAUSE

Backloaded design required that the cutters be changed from inside the cutterhead with limited work room in a hostile environment. The design used wedges to take all the cutter thrust load. The wedges frequently seized in position and had to be removed by hammering.

INTERIM SOLUTIONS

The wedges were coated with an anti-seizing compound that minimized rusting and made removal of the wedges easier.

RECOMMENDATIONS

Use an open face, self-cleaning cutterhead with ample room on either side for easy access.

CUTTERHEAD

Problem 11 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Flight conveyor replacement required excessive time, approximately 10 working shifts.

CAUSE

The cutterhead design required the flight conveyor to be removed as follows:

- o The components were disassembled into the largest pieces that could be snaked through the cutterhead and the trapdoor in the machinery deck.
- o A combination of manhandling and hoisting was required in four separate steps to remove the piece from the cutterhead into the mancage for hoisting to the surface.

The procedure was reversed for assembly with no assurance that the parts would interchange.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Replace the original cutterhead with an open face, self-cleaning cutterhead using vacuum muck pickup and incorporating these features:

- o Open top cutterhead so that all assemblies within are accessible by a crane from surface.
- o Self-aligning bolt-ons that can be removed and replaced in one working shift.
- o Sufficient room to accommodate all of the underground crew.

CUTTERHEAD

Problem 12 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Cutter housings restricted the flow of muck across the face.

CAUSE

When installed, new cutters were 13 inches in diameter. They were replaced when the rings had worn down $3/4$ inches at which time the diameter was $11\frac{1}{2}$ inches. This left approximately $1\frac{1}{2}$ inches between the shaft bottom and the cutter shaft housing and 8 inches to the cutterhead face. It was felt that the small clearance under the housing made each cutter assembly interfere with the planned movement of muck to the pickup point.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Replace the original cutterhead with an open face, self-cleaning cutterhead to prevent muck accumulation. Cutters should be rearranged to eliminate "fences". Using a large diameter cutter to attain more clearance has been proposed. However, it is not recommended for the following reasons:

- o Larger diameter cutters require larger bearings, housing, rings and more material. The unit cost is proportionately higher.
- o Operational experience indicated that, for a given thrust loading, the BSB lost significant performance when one-third of the cutters required replacement. Since cutters bore by preloading the rock, the replacement is determined by the pressure imparted on the rock. Therefore, the larger diameter cutter will have to be replaced when its contact area is the same as the smaller cutter. At that time, it will not have had comparable diametrical wear. Consequently, the boring cost per foot will be increased by the additional cost of the larger cutters.

CUTTERHEAD

Problem 13 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Inability of the operator to observe the shaft did not permit reducing the flow of water during boring. The large volume of water flowing to the settling ponds overloaded them causing an overflow of contaminants to the nearby stream.

CAUSE

Operator could not see the shaft bottom or the discharge of muck into the skip-loading hoppers. Also, the water addition at the face was not controlled by the operator. Therefore, boring rates and water addition could not be coordinated.

INTERIM SOLUTIONS

Toward the end of the project, the decant from No. 2 settling pond was pumped through a cyclone for solids removal, then reused.

RECOMMENDATIONS

Replace the original cutterhead with an open face, self-cleaning cutterhead through which the operator can observe the shaft bottom and add water only as needed to suppress dust and prevent muck sticking.

CUTTERHEAD

Problem 14 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The Moyno dewatering pumps plugged with muck.

CAUSE

The suction screen was purposely omitted during the design stage because the closed cutterhead precluded servicing of the suction or cleaning of the screen.

INTERIM SOLUTIONS

The pumps were removed. Portable air-driven centrifugal and diaphragm pumps were used.

RECOMMENDATIONS

A pump normally will not be required because the vacuum pickup will keep the shaft dewatered. For those times when additional dewatering is required, such as during lengthy shutdowns, an air-driven, piston-type, low volume, high pressure pump should be used to pump the water directly to the surface. These pumps are capable of handling some solids.

CUTTERHEAD

Problem 15 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

There was some risk of a miner getting a severe injury when climbing through the machinery deck to get in or out of the cutterhead.

CAUSE

There was no interlock between the cutterhead and machinery deck. The operator normally started the cutterhead on voice command and there was always the risk that he could mistake one command for another.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Situate the operator so that he has full view of the cutterhead exit point. Electrical interlocks can become inoperative or can be bypassed; therefore, a combination visual-mechanical and a redundant electrical interlock should be used.

CUTTERHEAD

Problem 16 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

A failing drive motor gear box could not be disengaged from the bull gear; therefore, further damage would occur with continued rotation.

CAUSE

The clutch was located between the drive motor and the gear box so that when the drive motor was disconnected, the bull gear continued to drive the gear box.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Install a mechanical clutch between the gear box and bull gear. This clutch could be a simple disconnect that moves the gear box drive pinion away or up from the bull gear.

CUTTERHEAD

Problem 17 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The inching-motor driven-gear stripped.

CAUSE

Operator rotated the cutterhead with the drive motors when the inching-motor was engaged.

INTERIM SOLUTIONS

The No. 6 drive motor and clutch assembly were removed to change the driven gear in the clutch housing.

RECOMMENDATIONS

Install inching-motor driven-gears in the clutch housing and mounting brackets so that if one gear fails, the inching-motor can be transferred to another clutch housing for rotation of the cutterhead. This would provide total interchangeability of parts. An air or hydraulic starting motor should be used with a bendix spring that disengages the motor when the cutterhead is rotated. An air starting motor has the advantage of requiring only one air hose to power the unit, is portable and available off the shelf.

CUTTERHEAD

Problem 18 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

When a drive-motor gear box was removed, both muck and water fell from the machinery deck into the main bearing and bull gear cavity. The muck accumulated and contaminated the lubrication oil.

CAUSE

The machinery deck (cutterhead support) was flush with the drive-motor mounting flange. When the seal was broken, there was no restriction to prevent contaminants from flowing into the well.

INTERIM SOLUTIONS

Special efforts were made to clean the area around the gear box prior to breaking the seal.

RECOMMENDATIONS

Raise the machinery deck mounting flanges three to four inches to provide a barrier to all contaminants during the gear box change.

CUTTERHEAD

Problem 19 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Twelve drive-motor gear boxes failed during 600 feet of boring.

CAUSE

Lubrication oil was contaminated with muck with metallic particles from gear boxes that had failed and could not be disconnected from the bull gear.

INTERIM SOLUTIONS

- o All possible sources of contamination to the main bearing seal and bull gear cavity were either eliminated or minimized as soon as they were identified.
- o Filters were changed frequently in an attempt to clean up the oil.
- o A separate filtering circuit was added to compliment the filter system.
- o Frequent oil samples were taken and analyzed and the oil changed as required.

RECOMMENDATIONS

- o Replace the mechanical muck system with the vacuum muck pickup system to eliminate buildup of muck under the bearing seal.
- o Install a roof over the main bearing inner seal to deflect contaminants away from the seal.
- o Replace the original lubrication system with the one recommended in the lubrication section of this report.

CUTTERHEAD

Problem 20 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The o-ring seal between the gear box and the main bearing - bull gear cavity was ineffective in preventing contamination of the lube oil.

CAUSE

Muck accumulated in the bulkhead.

INTERIM SOLUTIONS

Bulkheads were completely cleaned after the gear box was removed. This necessitated changing the oil and cleaning the bull gear cavity.

All openings, such as those located in adjoining bulkheads (interconnected with cutouts) and under the lubrication tank, were sealed.

RECOMMENDATIONS

On the modified BSB, all the cutouts to adjacent bulkheads and leakage paths from the machinery deck should be sealed to isolate each gear box bulkhead.

The o-ring seal should be relocated to the level of the machinery deck.

CUTTERHEAD

Problem 21 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Attempts at dry boring shortened cutter life.

CAUSE

Since little water was available to remove the heat as in wet boring, the heat buildup baked the grease from the bearings causing the cutter ring to drag.

INTERIM SOLUTIONS

On the final attempt to bore dry, water spray nozzles were attached to the cutterhead to cool the cutters. They were not used because the transition from wet to dry boring could not be made.

RECOMMENDATIONS

The recommended steep sided, self-cleaning cutterhead with vacuum pickup will eliminate most of the regrinding, thereby reducing heat buildup. Water or air/water jet assists at the cutters could be added if needed to suppress the dust and keep the cutters cool.

CUTTERHEAD

Problem 22 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Air clutches driving the cutterhead overheated when they were actuated to begin cutterhead rotation.

CAUSE

There was insufficient air volume to quickly interlock the plates. Prolonged slippage caused the plates to overheat from friction.

INTERIM SOLUTIONS

A larger valve was installed to increase air volume to the clutches and clutch air pressure was increased to make the interlock more positive.

RECOMMENDATIONS

Install a mechanical clutch. See problem 16 of 23.

CUTTERHEAD

Problem 23 of 23

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Gage cutters lasted seven times longer than cutters on the inside (flatter) areas of the face.

CAUSE

The portion of the cutterhead where the gage cutters were located bored the rock at an angle greater than the angle of repose so that area was self-cleaning.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

The recommended self-cleaning cutterhead with vacuum pickup is expected to increase the life of the inside cutters to approximately that of the gage cutters.

MUCK PICKUP

Problem 1 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Flight conveyors required excessive maintenance (approximately one-half of the total BSB maintenance time).

CAUSE

The use of flight conveyors in the abrasive conditions encountered is a misapplication. High wear appears to be inherent in a mechanical system forced to operate in the abrasive environment encountered in mechanical shaft drilling.

INTERIM SOLUTIONS

Some improvement was effected by replacing the chain guide rollers with rails and installing better seals in the bearings.

RECOMMENDATIONS

Replace the mechanical muck pickup with a vacuum system.

MUCK PICKUP

Problem 2 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The flight conveyor chains had to be replaced approximately each fifty feet of boring which was an equivalent of about 100 hours of boring time.

CAUSE

The chain links were castings without bushings or seals. They were originally designed for handling nonabrasive, self-lubricating materials such as coal. The rock on the project was very abrasive and varied from a soft siliceous shale to a hard 40,000-psi sandstone.

Abrasion was further compounded by excessive flexing of the chains when rotating around the small diameter sprockets and making sharp inclined bends.

INTERIM SOLUTIONS

- o The chains were heat treated.
- o Links were removed to shorten the chain as the chain wore and became too long.
- o A chain constructed of links with varying heat treatments and materials was tested and evaluated.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum pickup that has only one moving part exposed to the muck. Those stationary parts that are exposed to high wear can be selectively made of abrasion resistant materials to give extended life.

MUCK PICKUP

Problem 3 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The complete flight conveyor assemblies had to be replaced after about 200 feet of boring which was equivalent to approximately 400 hours of boring time.

CAUSE

Failure was caused by abrasion wear. The degree of wear increased over the life of the project because of accumulating misalignment each time a flight conveyor assembly was replaced and decreasing boring performance resulting from wear of the fixed center scrapers.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Replace the original cutterhead with a self-cleaning cutterhead without scrapers and replace the mechanical muck pickup with a vacuum pickup that would be free of alignment problems.

MUCK PICKUP

Problem 4 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

A replacement flight conveyor was often misaligned with respect to its companion on the cutterhead.

CAUSE

The original recessed cutterhead interface alignment bolts were difficult to remove and subsequently were burned off. Henceforth, all replacements were welded in place instead of bolted and each installation further obscured the references used for alignment.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

All wear components on the BSB should be simple bolt-on unit assemblies, rebuilt and tested on the surface, lowered directly into the mounting position and bolted into position. Components should be designed so they can be replaced in less than one shift. This would improve dependability and alignment of the replacement, resulting in better machine utilization.

MUCK PICKUP

Problem 5 of 17

OPERATIONAL PROBLEM EXPRIENCED OR ANTICIPATED

A replacement flight conveyor chain had to be custom fitted to the main frame.

CAUSE

The idler sprocket was misaligned when the complete flight conveyor was replaced.

INTERIM SOLUTIONS

The corners and ends were burned off the chain paddles to minimize hangups. Each modification had a disadvantage in that the size of the paddle and the muck carrying capacity of the flight conveyor were reduced.

RECOMMENDATIONS

Replace the mechanical muck pickup with a vacuum pickup that can be repaired with bolt-on, surface rebuilt assemblies in one shift. This would ensure minimal alignment problems.

MUCK PICKUP

Problem 6 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Repairs and replacements of the flight conveyor idler assembly resulted in frequent interruptions to boring.

CAUSE

The idler assembly consisted of a shaft, bearings, seal and sprocket. The problems that caused the premature idler sprocket failures are as follows:

- o As the idler was being assembled in the cutterhead, dirt would be inadvertently introduced into the bearings,
- o Bearings were not adequately sealed and would pickup dirt while inundated in the muck slurry,
- o Shaft mounting was misaligned with the flight conveyor main frame during replacement.

INTERIM SOLUTIONS

The design was changed to a sealed, one piece assembly identical to the construction of the cutters. Since the modified sprocket wasn't installed until near the end of the project, there was insufficient time to evaluate the change.

RECOMMENDATIONS

Replace the mechanical muck pickup with a vacuum pickup that does not use bearings nor any moving parts directly exposed to muck.

MUCK PICKUP

Problem 7 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Bracing to the flight conveyor drive motor and gear box had to be hand fitted each time the flight conveyor assembly was replaced.

CAUSE

The alignment of the installed flight conveyor assembly and cutterhead was unique to each installation.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Replace all wear components on the BSB with bolt-on spare assemblies that are rebuilt and tested on surface, lowered directly into mounting position from the surface and bolted in position in one shift. Since the mechanical muck pickup would be replaced with a vacuum pickup and the system serviced as described, all supports such as bracing would be standardized and reused.

MUCK PICKUP

Problem 8 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Flight conveyor chain paddles plugged when handling sticky muck.

CAUSE

Moisture content of the muck dropped below 10 percent which, in combination with the high percentage of fines, caused the muck to become cohesive.

INTERIM SOLUTIONS

The operator stopped the BSB and the crew removed the muck by hand.

RECOMMENDATIONS

The mechanical pickup system and the proposed vacuum system will not continuously handle sticky muck. The muck must be kept dry or with a moisture content above 10 percent. Dry muck is undesirable because it apparently causes premature cutter failures. See problem number 21 of 23 in the Cutterhead section.

MUCK PICKUP

Problem 9 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

When operating with free flowing muck, the flight conveyors were reversed as many as six times per minute to prevent the chain from becoming overloaded.

CAUSE

The overloading was a pyramiding effect of:

- o scrapers dozing more muck into the pickup area than the flight conveyors were capable of removing,
- o bucket elevators having substantially less capacity than the flight conveyors.

INTERIM SOLUTIONS

The hydraulic pressure to the bucket elevator drive motors was increased and the rotational speed of the flight conveyors was decreased in an attempt to balance their performance.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum muck pickup that eliminates one muck transfer point and the subsequent performance balancing problems.

MUCK PICKUP

Problem 10 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The flight conveyors did not have enough power.

CAUSE

More power was needed than originally anticipated because of:

- o Excessive chain bending caused by small sprockets and 50° bends in the vertical plane.
- o Paddles attempting to compress muck in the trough.
- o Misalignment of the interfacing components.
- o Operation of drive motors with lowered pressures to reduce hydraulic breakdowns.

INTERIM SOLUTIONS

The flight conveyor pumps were replaced with those of similar design but larger volume. The pumps were installed near the end of the project and the BSB bored only 30 feet with the new pumps; therefore, results could not be evaluated.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum muck pickup.

MUCK PICKUP

Problem 11 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

One flight conveyor always picked up more muck than its companion on the cutterhead.

CAUSE

Misalignment during replacement caused differences in:

- o Pickup heights so that one flight conveyor was closer to the face than the other. As expected, more muck was dozed into the pickup nearest the face,
- o Chain paddle clearances in the trough,
- o Interface between the flight conveyor and bucket elevator,
- o Drive motor torque requirements.

INTERIM SOLUTIONS

Efforts to balance the muck pickup rates included:

- o Adding extension lips to the pickups to compensate for the difference in heights,
- o Raising the bucket elevator idler sprockets to minimize digging and increase effective bucket capacities,
- o Modifying the muck chute at interfaces between each flight conveyor and bucket elevator,
- o Adjusting individual flight conveyor speeds to match capacity of its companion elevator.

RECOMMENDATIONS

Replace the flight conveyors and bucket elevators with a vacuum pickup system.

MUCK PICKUP

Problem 12 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The bucket elevators were underpowered.

CAUSE

Lack of power for the bucket elevator resulted from use of a design formula which was later found to be inadequate for the actual operating conditions. The additional weight of water from wet boring further strained the system. A third factor was the wearing of the 7-inch fixed scrapers to 3½ inches causing the buckets to dig accumulated muck at the bottom of the bucket elevator well.

INTERIM SOLUTIONS

Improvements were made by:

- o increasing the drive motor hydraulic pressures,
- o replacing the original buckets with smaller-sized buckets,
- o adding 4-inch, fixed scrapers to the cutterhead,
- o raising the bucket elevator idler sprockets,
- o increasing the bucket elevator chain speed,
- o replacing the bucket elevator chains.

RECOMMENDATIONS

Replace the original cutterhead and mechanical muck pickup with a self-cleaning cutterhead and vacuum pickup.

MUCK PICKUP

Problem 13 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The bucket elevators appeared to have less capacity than the flight conveyors.

CAUSE

The bucket elevators lacked the power necessary to match the capacity of the flight conveyors (see Problem 12 of 17). The bucket elevators digging in the accumulated muck resulted in partial filling of the buckets which further reduced their capacity to handle muck from the flight conveyors.

INTERIM SOLUTIONS

Attempted improvements included:

- o addition of 4-inch fixed scrapers to the cutterhead to doze the muck away from the wells,
- o raising the idler sprocket to minimize the amount of muck the buckets dig.

RECOMMENDATIONS

Replace the original cutterhead with a self-cleaning cutterhead that does not require scrapers and replace the mechanical muck pickup with vacuum muck pickup.

MUCK PICKUP

Problem 14 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Muck spilled from the bucket elevators, hung up on the structures in the inner tower and created a safety problem when the miners attempted to inspect or repair the system.

CAUSE

Muck spillage resulted from:

- o Excessive high or low travel rate. Low speeds allowed the buckets to become overloaded and spill the muck; whereas, high speeds caused the buckets to carry the muck past the discharge and dump the muck while returning to the bottom.
- o Overfilling the buckets when they were digging accumulated muck from the wells and also conveying muck from the flight conveyors.
- o A high water content that allowed the soupy muck to spill from the buckets as they were going over the top of the drive sprocket.

INTERIM SOLUTIONS

The inner tower was cleaned prior to working inside the tower. The resultant degree of safety was dependent on the effectiveness of the cleanup.

RECOMMENDATIONS

Replace the mechanical muck pickup with a vacuum muck pickup that has all the muck (rock, fines, water) totally enclosed from the face to the transfer point on top of the BSB.

MUCK PICKUP

Problem 15 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Considerable time was lost while making the flight conveyors operational after each replacement. Additional time was then lost attempting to improve performance.

CAUSE

Misalignment of components caused jamming.

INTERIM SOLUTIONS

The misaligned components were adjusted and modified until the system worked. Unfortunately as the reliability increased, the capacity of the system decreased.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum muck pickup. Since the worn components would be replaced by those rebuilt and tested on surface, introduced misalignment would be minimized and performance kept constant.

MUCK PICKUP

Problem 16 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Bucket elevator idler sprocket frequently had to be rebuilt, tightened and replaced.

CAUSE

Idler sprocket problems resulted from:

- o Continuous exposure to the accumulated muck inside the well and overflow from the flight conveyors.
- o Bearings were subject to considerably more impact load from digging, than they had been designed to withstand.
- o Bearings were not adequately sealed.
- o Retaining bolts holding the idler to its frame would stretch and then fail.

INTERIM SOLUTIONS

The idler sprocket was raised some five inches to improve overall bucket elevator performance.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum muck pickup.

MUCK PICKUP

Problem 17 of 17

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Bucket elevator chains had to be shortened at the approximate rate of one-half link for each 50 feet of boring. During some inspections, the plastic buckets attached to the chains showed signs of considerable abrasion and had pieces torn out.

CAUSE

Digging accumulated muck in the wells made the chain stretch, wore links, pins and bushings, and damaged the buckets.

INTERIM SOLUTIONS

- o Chains were shortened as required.
- o When worn enough to be considered a safety problem, both chains were replaced.
- o The original buckets were replaced with smaller buckets to determine if the buckets were hitting obstructions in the inner tower which would cause both a power loss and bucket damage. This was found not to be the case, and the original size buckets were reinstalled.

RECOMMENDATIONS

Replace the original cutterhead and mechanical muck pickup with a self-cleaning cutterhead and vacuum muck pickup.

HYDRAULICS

Problem 1 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Fire Resistant (FR) fluids increased pump and motor wear to an unacceptable level.

CAUSE

Suspected causes of the high level of wear include:

- o elevated corrosion rates which were caused by the water phase of the emulsified FR fluid
- o elevated temperatures
- o excessive pressures and velocities which caused partial demulsification of the FR fluid

INTERIM SOLUTIONS

Operation pressures were reduced and some components were modified to eliminate or reduce restrictions.

RECOMMENDATIONS

Simplify the hydraulic system and design it for lower operating pressures and flow rates. The BSB design should minimize the need for hydraulic pumps and motors. Pumps that cannot be eliminated should operate on demand only.

HYDRAULICS

Problem 2 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Propel cylinder flow control valves frequently plugged, making BSB steering erratic.

CAUSE

Restrictions in the valves demulsified the FR fluid. The separated water rusted the close tolerance internal parts.

INTERIM SOLUTIONS

The valves were either replaced or cleaned. The retrofit of different size valves was unsuccessful. Larger capacity valves made the BSB yaw and smaller valves resulted in a sluggish response.

RECOMMENDATIONS

Replace the flow control valves and essential bypasses that were needed to pressurize the thrust side of the propel cylinder, with the control valves on the reservoir side of the cylinders. With this change, the valves would be exposed only to the volume of FR fluid needed to actuate the system.

HYDRAULICS

Problem 3 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Operation of the propel cylinders became spongy, causing erratic steering.

CAUSE

Air was frequently sucked into the propel cylinders when the rear shield and gripper assembly weight was used to quickly collapse the propel cylinders in preparation for regripping.

INTERIM SOLUTIONS

- o Removed and later replaced the propel cylinder check valves.
- o Terminated use of the gripper assembly weight to collapse the propel cylinders.

RECOMMENDATIONS

Use pressurized propel cylinders, thereby preventing partial vacuums in the cylinders.

HYDRAULICS

Problem 4 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The 10-micron pressure filters collapsed, carrying filter particles into the hydraulic system.

CAUSE

The 10-micron size was too restrictive.

INTERIM SOLUTIONS

Changing all filters to the larger capacity, 25-micron size eliminated filter collapse.

RECOMMENDATIONS

Replace the 16 existing pressure filters with two large return line filters. One would serve as a standby. If the hydraulic system is used only on demand, as recommended, filter requirements would be minimized.

HYDRAULICS

Problem 5 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Excessive failure of piston and vane pumps.

CAUSE

The failures resulted from:

- o pump suction restrictions, resulting in cavitation,
- o breakdown of FR fluid caused by excessive temperatures and pressures.

INTERIM SOLUTIONS

To minimize failures:

- o The FR fluid was changed frequently, primarily to control contamination,
- o Suction screens were eliminated,
- o Operating pressures of the flight conveyor and bucket elevator were reduced,
- o Reduction of FR fluid viscosity was attempted by cycling on and off prior to actual startup.

RECOMMENDATIONS

- o Eliminate cavitation by increasing the pump suction size at least 50 percent beyond that recommended by pump manufacturers for mineral based oil.
- o Supercharge the hydraulic reservoir.
- o Use a demand hydraulic system with a gear pump that has minimum internal exposure to the limited FR fluid lubrication.

HYDRAULICS

Problem 6 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The hydraulic reversing system on the flight conveyors cycled excessively.

CAUSE

The reversing system frequently reacted to momentary spikes that were normal operating fluctuations of pressure.

INTERIM SOLUTIONS

The system's sensitivity was adjusted, isolated, and finally the reversing mechanism was removed.

RECOMMENDATIONS

Reversing mechanism should have sensitivity controls adequately dampened to prevent excessive cycling.

HYDRAULICS

Problem 7 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The FR fluid, when not used for several days, demulsified and corroded the internal parts of many hydraulic components.

CAUSE

The separation resulted from instability of the fluid. This separation was also observed in drums on surface.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Provisions should be made to activate all of the hydraulic functions periodically.

HYDRAULICS

Problem 8 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The grippers relaxed and allowed the rear shield to collapse the propel cylinders, wedging the rear shield against the shaft wall. Repositioning to resume boring required 1½ shifts.

CAUSE

The propel cylinder over center valves leaked, permitting the weight of the rear shield to collapse the propel cylinders at unequal rates.

INTERIM SOLUTIONS

The valves were cleaned and/or replaced whenever leakage became apparent. Gages were placed on the propel cylinders to monitor leakage.

RECOMMENDATIONS

- o Make the gripper circuit more reliable.
- o Collapse the propel cylinders between shifts so the rear shield cannot move if the hydraulic system fails.

HYDRAULICS

Problem 9 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The FR fluid was contaminated over the life of the project despite frequent filter changes and extensive filtering.

CAUSE

Contamination was introduced each time a hydraulic component was replaced or repaired.

INTERIM SOLUTIONS

None. Efforts to further filter the FR fluid increased the complexity of the system and resulted in additional maintenance.

RECOMMENDATIONS

- o Replace the mechanical muck pickup with a vacuum muck pickup which eliminates 200 of the 230 down-hole hydraulic horsepower.
- o Replace the existing hydraulic system with a demand system that uses fluid only as required.

HYDRAULICS

Problem 10 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Service life of rebuilt pumps was short, occasionally as little as four hours.

CAUSE

Not determined.

INTERIM SOLUTIONS

- o Pumps were rebuilt by three reputable shops, two of which used factory original parts.
- o Rebuilding procedures were checked by actual observation to confirm that the work was done satisfactorily and that the pumps were tested to factory specifications.

RECOMMENDATIONS

Use simpler design gear pumps that are less expensive and would be expected to give longer life.

HYDRAULICS

Problem 11 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

FR fluids were used outside the range of the 100° to 150°F temperatures recommended by the manufacturers.

CAUSE

No provision was made to warm the fluid prior to startup during the winter nor to prevent overheating from extended usage in hot weather.

INTERIM SOLUTIONS

In cold weather, pumps were switched on-off several times prior to running to lessen the danger of cavitation. In hot weather, boring water and the FR fluid were passed through a heat exchanger to cool the FR fluid.

RECOMMENDATIONS

Warm the FR fluid by using a calrod heater to heat the fluid to 125°F before use on cold mornings. Use the air motor exhaust to cool the fluid to 125°F when operating under heated conditions.

HYDRAULICS

Problem 12 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Approximately one-fourth of the BSB downtime during the project was caused by hydraulic problems.

CAUSE

The excessive downtime resulted from:

- o frequent pump breakdowns and lack of redundancy to keep the BSB operational,
- o complexity of the system and resultant difficulty in identifying the causes of failures and making repairs,
- o combination of corrosion, contamination and FR fluid demulsification that plugged valves,
- o difficulty in working on the system without introducing contamination,
- o excessive automation that compounded the complex circuitry,
- o use of hydraulic pumps and motors for applications that could have been powered by compressed air.

INTERIM SOLUTIONS

Components were repaired as required to restore operational capability.

RECOMMENDATIONS

- o Replace the hydraulic driven mechanical muck pickup with a non-hydraulic vacuum muck pickup.
- o Eliminate the gripper pump and use air-actuated intensifiers to produce the required pressure.
- o Pressurize the propel cylinders and provide control by metering the rod end discharge flow.
- o Operate all the remaining lineal motions with an air-driven, demand type hydraulic system.

HYDRAULICS

Problem 13 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The gripper ring cylinders occasionally lost pressure, permitting the BSB to drop when the cutterhead was off the face, or to slip when thrust was applied to the cutterhead while boring.

CAUSE

The two primary causes for a loss of gripper ring pressure were:

- o Loss of pump pressure because of wear.
- o Limitations of the barrel hoop design which made the gripping ability of the ring dependent on the performance of each of the six hydraulic cylinder check valves.

INTERIM SOLUTIONS

- o The pump was replaced each time it lost pressure. During the second half of the project, a different brand of pump was used, and the load was shared with a second pump.
- o The check valves were cleaned and/or replaced when they leaked.

RECOMMENDATIONS

Replace the high pressure pump with an air-actuated intensifier.

HYDRAULICS

Problem 14 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The polishing circuit that was installed to continuously filter the hydraulic fluid was ineffective.

CAUSE

The system was used only when the BSB was operational. If used when unattended, a hose failure would have resulted in drainage of the entire hydraulic system.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Reducing the number of hydraulic components and operating those used on a demand system will minimize the need for supplementary filtering.

HYDRAULICS

Problem 15 of 15

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Hydraulic flight conveyor drives gave poor performance and reliability.

CAUSE

The hydraulic system was unable to handle the frequent reversals required to keep the chain from becoming muck bound.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Replace the flight conveyor with a vacuum muck pickup system.

LUBRICATION

Problem 1 of 5

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Failure rate of the lubrication system was excessive.

CAUSE

The lubrication system was too complex for the application. It consisted of:

- o a reservoir and sump, each of 165-gallon capacity, with oil pumped from the sump to the reservoir by a hydraulically driven scavenger pump,
- o one electrically driven hydraulic pump that drove two hydraulic motors, which drove two lube oil pumps, which pressurized the oil from the reservoir. The oil was injected into the six drive motor gear boxes and three main bearing lubrication points through two Trabon distributors.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Discard the present system as too complex when compared to the simple job requirement. On the modified BSB, use the main bearing and bull gear cavity as the only reservoir and circulate the oil by means of air-actuated barrel pumps mounted with their suctions in the cavity. On the conceptual redesign of the BSB, minimize the lubrication system by using sealed drive motor gear boxes and a pressurized, grease-packed main bearing and bull gear.

LUBRICATION

Problem 2 of 5

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Frequent losses of pressure in the lubrication system activated the low pressure safety switch, shutting down the BSB.

CAUSE

The electrically driven hydraulic pump powering the lubrication system lost pressure because of cavitation and wear. There was a subsequent decrease in lubrication oil pressure.

INTERIM SOLUTIONS

The low lubrication pressure shutdown switch was bypassed to keep the BSB operational until the end of the boring cycle. At the end of the boring cycle, the hydraulic pump cartridge or the entire pump was replaced, as required.

RECOMMENDATIONS

On the modified BSB, use an air-actuated barrel pump. On the conceptual redesign of the BSB, use sealed gear boxes and a pressurized, grease-packed main bearing and bull gear.

LUBRICATION

Problem 3 of 5

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Lubrication oil overflowed from the lubrication tank located on the machinery deck.

CAUSE

Flow rate from the scavenger pump was not balanced with the flow rate from the pressure pump. The excess frequently was greater than the lubrication tank gravity overflow line could return to the sump.

INTERIM SOLUTIONS

The scavenger pump flow was decreased so that it would not exceed the capacity of the overflow.

RECOMMENDATIONS

On the modified BSB, discard the lubrication tank and scavenger pump, use the sump as a reservoir for lubrication oil, and pressurize the system with air-actuated barrel pumps. On the conceptual redesign of the BSB, use sealed gear boxes and a pressurized, grease-packed main bearing and bull gear.

LUBRICATION

Problem 4 of 5

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

While boring the last 200 feet, lubrication oil had to be changed every 40 hours of boring time as a result of contamination.

CAUSE

A five-inch piece of the main bearing seal was discovered missing when the BSB was demobilized. In retrospect, this was the principal entry point for the contaminants. The seal was not accessible when the BSB was assembled.

INTERIM SOLUTIONS

- o A trough was installed between the towers to divert muck that overflowed from the carousel away from the seal.
- o Miners were stationed at the muck hoppers to alert the operator of any carousel overflows so the BSB could be stopped.
- o All detectable leaks into the sump were sealed.

RECOMMENDATIONS

Replace the mechanical muck pickup with the vacuum pickup to achieve these secondary benefits:

- o minimize the accumulation of water and muck on the BSB and consequent oil contamination.
- o eliminate the inner tower on the modified BSB and both towers on the conceptual redesign of the BSB.

As a result of eliminating the inner tower, the seal area would be exposed and could be protected with a metal shed that would:

- o deflect both water and muck
- o allow inspection of the seal as required
- o give ample access for replacement of the seal

LUBRICATION

Problem 5 of 5

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

A main bearing failure could result from either inadequate or contaminated lubrication oil. Replacement of a failed main bearing would have required the BSB to have been removed from the shaft.

CAUSE

The size and location of the bearing prevented it from being replaced with the BSB in the shaft.

INTERIM SOLUTIONS

A significant portion of BSB maintenance time was directed towards keeping the oil clean to minimize the possibility of a main bearing failure.

RECOMMENDATIONS

None on the modified BSB, except to simplify the lubrication system and analyze the oil frequently for early detection of any contamination. The conceptual redesign BSB would be reduced in weight and bulk so that it could be removed from the shaft in one piece for major repairs.

ELECTRICS

Problem 1 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Corrosion was found in many of the control boxes while the BSB was being assembled on the field trial site.

CAUSE

The boxes were not protected when the BSB was shipped from the manufacturer and, being designed as "permissible", they "breathed" with changes in air pressure. Subsequently, temperature changes caused condensation which accelerated corrosion.

INTERIM SOLUTIONS

The salvageable boxes were repaired; those beyond repair were replaced.

RECOMMENDATIONS

The BSB will be exposed to shaft sinking conditions at least as severe as those encountered in shipping; therefore, the boxes should be initially waterproofed so that they will withstand high humidity environments. An alternate recommendation is to use nonelectric controls.

ELECTRICS

Problem 2 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The transformer that reduced power from 7200 to 950 volts was mounted on the galloway, severely limiting usage of the galloway.

CAUSE

The MSHA variance required that the non-permissible transformer be stationary when energized. Also, while the transformer was energized, the case had to be connected to both the intake and exhaust ventilation pipes to insure its positive ventilation. To remain in compliance, the galloway could not serve its prime function of being an independent work platform used for lowering concrete forms, pouring the concrete liner, and advancing shaft service lines while the BSB was in operation.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

On the modified BSB, mount the transformer on a separate platform above and independent of the galloway and run a longer umbilical power cable to the BSB. This platform would be bolted to the shaft walls and lowered in 100-foot or 200-foot increments using the galloway as the moving mechanism.

ELECTRICS

Problem 3 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The controls, functions, and contacts that did not generate heat experienced considerable corrosion.

CAUSE

The BSB was subjected to both high humidity and splashing water for over 18 continuous months during the field trial.

INTERIM SOLUTIONS

Electrical components were dried, inspected, and cleaned or replaced as they became inoperative.

RECOMMENDATIONS

On the modified BSB, replace as many of the electrical components as practical with nonelectric components. All electric components should be removed, baked to remove any moisture, and reconditioned on an annual basis and between shaft projects.

GUIDANCE

Problem 1 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The operator had difficulty converting guidance readouts into steering corrections.

CAUSE

The guidance readouts were in four quadrants, that is, on the X and Y axes, while normal corrections were made by varying the flow of hydraulic fluid to each of three banks of propel cylinders located 120° apart. Major steering corrections were made by adjusting the side supports which were also located 120° apart.

INTERIM SOLUTIONS

There were no serious steering problems, since the BSB bored at less than 20 percent of the anticipated rates. At these reduced rates, the operator had more than adequate time to make steering corrections. Had the BSB been operating at the anticipated penetration rate, steering would have been difficult.

RECOMMENDATIONS

The three guidance readouts displayed:

- o the projected position of the BSB 25 feet in advance of the cutterhead,
- o the present location of the cutterhead in reference to the theoretical shaft centerline,
- o tilt of the BSB from the vertical.

These guidance readouts should be retained. One display target should be installed with the theoretical shaft centerline as the bullseye. The position indicator should be the projected position, 25 feet ahead of the cutterhead.

Steering should be with a single joystick connected to the hydraulic cylinders so that the cutterhead would move in the same direction the joystick is moved.

GUIDANCE

Problem 1 of 10

Page 2

On the modified BSB, use radial readouts on the target to correspond with the propel and side support cylinders. On the conceptual redesign of the BSB, the target should read in quadrants to correspond with the X and Y axes locations of the propel and side support cylinders.

GUIDANCE

Problem 2 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The gripper ring and/or rear shield occasionally blocked one of the laser beams, blinding the BSB guidance system.

CAUSE

The laser beams passed through 7½-inch diameter cutouts in the gripper ring and rear shield. Differential ground conditions or a shaft deviation caused horizontal displacement or inclination of the rear shield or gripper, blocking the beam.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Locate only one laser beam in the center of the BSB so that no reasonable degree of tilt would cause interference with the beam. The diameter of the target will limit tilt and horizontal displacement. Rotation of the BSB would be compensated with a north seeking reference point.

GUIDANCE

Problem 3 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Laser targets on the BSB machinery deck were frequently coated with muck and had to be cleaned.

CAUSE

Targets were located at the perimeter of the BSB (laser beam passed through pipes imbedded in the concrete lining to reach the BSB) so they were very susceptible to muck spills, seeping ground water and concrete spills.

INTERIM SOLUTIONS

Air and water jets were used to clean the targets. The use of water caused problems with the laser beam, but the air jet appeared to give good results.

RECOMMENDATIONS

Locate the laser target in the center of the BSB where it would be more protected from ground water and concrete spills. The vacuum pickup would minimize muck spills. The target should be kept clean by blowing ejector induced air across the target.

GUIDANCE

Problem 4 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

More than 50 percent of the operator's attention was devoted to steering the BSB.

CAUSE

Deviation from the centerline was less than is required in conventional shaft sinking and less than was required contractually. If the operator had placed more emphasis on other functions, the maintenance possibly would have been lower and the overall BSB utilization higher.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Put steering in its proper perspective as one of many operator functions, rather than his primary function. This would be accomplished by allowing more shaft deviation (up to the limits specified in the shaft contract).

GUIDANCE

Problem 5 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Laser beams diverged when surface air temperature was higher than 60° F and converged when the air temperature was lower.

CAUSE

The problem became apparent below 500 feet. The deflection was apparently caused by the difference between the constant shaft wall temperature and fluctuating downcast ventilation air temperature. This, in combination with the extended distance the beam was projected, resulted in the beam hitting the sides of the tubes and not reaching the BSB with a usable intensity.

INTERIM SOLUTIONS

- o Laser tubes were rodded to remove any obstructions.
- o Tubes were checked for alignment.
- o Flow of air into the tubes was increased to increase turbulence.
- o Hot compressed air was blown into the tubes to melt any ice buildup.
- o Laser guns were moved from the surface to an underground position.

RECOMMENDATIONS

Since there is little advantage to using the laser beams over long distances, the laser guns should be moved to a deeper location as soon as deviation of the beam is detected (possible at 300-foot intervals).

GUIDANCE

Problem 6 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Lowering the concrete forms while the BSB was boring intermittently blocked the laser beams, temporarily eliminating the needed steering guidance.

CAUSE

This was caused by a combination of:

- o design oversight that did not initially identify the problem,
- o no effort afterwards to make those design changes necessary to lower the forms without interfering with the beams,
- o operator's overdependence on the need for continuous beams to operate the BSB

INTERIM SOLUTIONS

No work was done on the forms that would interfere with the beams while the BSB was boring.

RECOMMENDATIONS

On the modified BSB, rebuild the curb ring to prevent blockage of the laser beams. Use spacers between the forms and wall to keep the forms from moving into the beam area.

On the conceptual redesign of the BSB, either use one laser in the center of the BSB or four lasers, in quadrants, so that the BSB could steer when any two beams were able to reach their target.

GUIDANCE

Problem 7 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The BSB could not bore while repairs were made on the laser guidance system.

CAUSE

No redundancy in the design to allow for malfunctions or repairs.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

For minimum cost installation, a single laser gun in the center is most appropriate; however, for maximum utilization of the BSB, the following redundancy in the guidance system is needed:

- o Install four laser guns with their targets 90° apart so that any two beams will give the necessary guidance.
- o When centering the forms, two diametrically opposing beams can be used to line up the curb rings, and the remaining pair will provide the required guidance.

GUIDANCE

Problem 8 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Water splattered on the underground laser guns, diffusing the beam of the replacement unit.

CAUSE

The lens was at the end of the tube on the replacement gun and susceptible to all outside interferences. The replacement gun was the only unit available when one of the original pair failed.

INTERIM SOLUTIONS

Boring was stopped when the beam became ineffective. The exposed lens was cleaned and dried. Consideration was given to sealing the underground laser guns within their housings, but it was not done.

RECOMMENDATIONS

The original pressurized laser tube system can be used by sealing the guns in their housings. An alternate method would be to use laser guns with recessed lenses and hoods for protection against falling debris.

GUIDANCE

Problem 9 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Underground laser guns required two days for installation. The surface laser beams were intermittently blocked so the BSB was unable to bore.

CAUSE

No provisions had been made in the recess forms for mounting the laser guns.

INTERIM SOLUTIONS

The installation was done from the emergency hoist cage and consisted of drilling holes in the concrete liner, bolting a mounting adapter to the liner, attaching and aiming the laser gun.

RECOMMENDATIONS

Construct the housings on surface, using lightweight plate, and mount them on the laser tube prior to downhole installation. Include an adapterplate and provisions to add a sealed door. The laser guns should be installed from the galloway during normal shutdowns, thereby eliminating any loss of boring time.

GUIDANCE

Problem 10 of 10

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The operator was isolated from the actual boring and was expected to make instantaneous decisions based only on instrument readouts.

CAUSE

The operating console was cradled inside the BSB so that the operator could not observe the cutterhead in action. The number of guidance and functional readouts was excessive in that the operator's attention often was diverted from the more important, immediate problems.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Reposition the operating console and operator so that the operator can see the face and evaluate the action of each function relative to boring.

Replace most of the gages with a few selective lights that indicate the availability of the BSB to bore. The removed gages should be installed on the machinery deck and monitored by the technician/mechanic who is responsible for keeping the BSB operational.

HOISTING

Problem 1 of 6

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The skips frequently would not trip the interlock to open the hopper doors.

CAUSE

The bottom of skip tubes were enclosed, trapping the muck spilled from the hopper and skip doors. This muck buildup prevented the skip from sitting on the chairs and being in position to trip the interlock.

INTERIM SOLUTIONS

Small holes were burned in the bottom of the tubes. These holes drained the water and fines but retained the larger pieces of muck. The muck buildup was shoveled out as required to keep the interlock operational.

RECOMMENDATIONS

On applications using skip hoisting, the bottoms of the tubes should be open so that the muck falls directly through the open cutterhead and back to the face. When the pneumatic hoisting system is used, the skip tubes would be eliminated.

HOISTING

Problem 2 of 6

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The bottom dump skips leaked considerable amounts of muck into the skip tubes, onto the BSB while being hoisted and on the shaft cover and doors when being dumped.

CAUSE

The muck was a slurry and the skips were not designed to handle muck with such a high percentage of water and fines.

INTERIM SOLUTIONS

The skip doors were gasketed to minimize leakage when closed. The bottom of the skips were skirted to direct the flow out through the front of the skip door.

RECOMMENDATIONS

On applications using skip hoisting, installation should include:

- o bottom dump skips for dry muck and top dump skips for wet muck, or
- o multi-purpose skips that can be converted interchangeable from bottom to top dumping.

Either type would require dual dumping scrolls in the head-frame.

When the pneumatic hoisting system is used, the skips will not be required.

HOISTING

Problem 3 of 6

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

When any of the four hopper probes would hang up, the safety interlocks would shut down the BSB.

CAUSE

A hung probe erroneously indicated that its hopper was full. The hoisting system was so programmed that when both hoppers were indicated full, it would shut down the BSB.

INTERIM SOLUTIONS

One of the tasks assigned to one miner was to keep the probes free.

RECOMMENDATIONS

On applications using skip hoisting, probes of improved design should be used. An alternative would be to have a miner monitor the flow of muck from the vacuum pickup, through the air lock feeder and into the hoppers. By controlling the flow of muck manually, the probes could be eliminated.

When pneumatic hoisting is used, the hoppers will be eliminated but a miner would still be required to monitor the flow of muck through the interface between the vacuum muck pickup and pneumatic hoisting system.

HOISTING

Problem 4 of 6

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

When one of the muck hopper doors jammed open, the skip hoisting system was thrown out of synchronization.

CAUSE

The hopper door was closed by a timer. The hoisting system had no logic to handle any outside influences that prevented the door from closing, or even cycle the door in an attempt to clear the jam.

INTERIM SOLUTIONS

Although the control system had a manual mode of operation, it was connected to the same interlocks as the hopper doors and could not be used until the problem was corrected. Consequently, an electrician had to be summoned to open the control box and recycle the system each time the doors jammed.

RECOMMENDATIONS

On applications using skip hoisting, the same miner used to monitor the flow of muck from the vacuum muck pickup to the hoppers could manually load the measured muck into the skips. Interlocks would be eliminated and the hydraulically actuated, upward swinging door replaced with an air operated guillotine gate.

When the pneumatic hoisting is used, the hoppers would be eliminated.

HOISTING

Problem 5 of 6

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Piston rods in the hydraulic cylinders used to actuate the muck hopper doors frequently were bent, causing the doors to jam and/or the cylinders to leak.

CAUSE

The cylinder rods were too small to close the upward swinging skip loading doors against a hopper full of muck, or against a jammed boulder. The cylinder and door design was inadequate for the conditions encountered.

INTERIM SOLUTIONS

The problem was minimized by:

- o stationing a miner to wash down the muck before it built up and surged as the door closed,
- o installing a curtain at the back of the hopper to make the bottom self-cleaning.

RECOMMENDATIONS

Replace the mechanical muck pickup with a vacuum pickup to minimize the use of water and the many problems associated with attempting to handle slurries.

When skip hoisting is used with the vacuum pickup, the hopper bottom should be made steeper to minimize hangups, and the flow of pre-measured muck into the skip would be controlled with an air cylinder actuated guillotine door.

When pneumatic hoisting is used, the hoppers would be eliminated.

HOISTING

Problem 6 of 6

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The hoppers would not completely empty into the skips.

CAUSE

The time required for filling the hopper was long enough for the water and solids to separate and the solids to consolidate and cement to the bottom of the hoppers. These solids usually remained in place when the hopper was pulled, but it occasionally broke loose, jamming the door open and throwing the skip loading system out of synchronization.

INTERIM SOLUTIONS

- o An air-driven vibrator was mounted to the underside of the hopper. It was counterproductive, in that it further consolidated the solids.
- o The miner stationed at the hopper washed the accumulated solids into the skip as the hopper was pulled.

RECOMMENDATIONS

Replace the mechanical muck pickup with the vacuum pickup, thereby permitting a reduction of the quantity of water in the muck.

When skip hoisting is used with the vacuum pickup, it is reasonable to assume that the existing hoppers with a steeper bottom will be self-cleaning. If not, air-actuated ejectors should be installed.

The pneumatic hoisting system will not require hoppers.

TIME UTILIZATION

Problem 1 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

There were several labor walkouts on the project.

CAUSE

The walkouts were partly a result of poor communication and rapport between the miners and upper management.

INTERIM SOLUTIONS

The supervisors served as intermediaries, with some improvement in the dissemination of information to the miners.

RECOMMENDATIONS

Managers should be selected on a basis of both technical qualifications and ability to work equally well with both salaried and hourly personnel on the project.

TIME UTILIZATION

Problem 2 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The typical eight-hour shift produced only six hours of meaningful work.

CAUSE

Miners were paid for an eight-hour shift, portal-to-portal, with lunch included. A typical work shift included:

- o 15 minutes to lower the miners at the beginning of the shift
- o 30 minutes to perform preshift maintenance
- o 60 minutes for lunch
 - 15 minutes to hoist the men to the surface for lunch
 - 30 minutes for lunch
 - 15 minutes to lower the men after lunch
- o 15 minutes to hoist the men at the end of the shift

On Mondays, the mandatory safety meeting took an additional 30 minutes.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

To produce the project 25 feet of boring per day, the BSB must be manned around the clock. This can be accomplished by one of several industry used methods, two of which are:

- o Stagger the starting hours so that the key men, such as the operator mechanics, start work, eat lunch and quit work at different times, say two hours apart.

TIME UTILIZATION

Problem 2 of 11

Page 2

- o Have the shifts work six hours, starting when the miners are on the BSB, with no lunch break, and with pay for eight hours. This requires four shifts per 24 hours.

TIME UTILIZATION

Problem 3 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Contractor poured concrete only on day shifts.

CAUSE

This problem arose after the project went from 3 to 2 shifts per day. The reasoning was:

- o concrete supplier would not deliver concrete on night shift
- o management was always available on day shift to assist with the pour

INTERIM SOLUTIONS

None

RECOMMENDATIONS

A random check with concrete suppliers in the Bessemer area revealed that they would have delivered concrete at night for a \$15 per yard premium. A review of shift boss reports further revealed that on two occasions in May, 1979, concrete was poured on graveyard shift.

If it is necessary for management to be on the site to assist during concrete pours, management personnel should adjust their work hours to be on the site when concrete is poured.

TIME UTILIZATION

Problem 4 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Up to 1½ shifts were lost waiting to pour concrete during a day shift.

CAUSE

When the project was only working two shifts per day, contractor's policy was that concrete would be poured only on day shift and that the forms had to be ready to accept concrete by lunchtime. If the forms were not ready, the pour was postponed until the following day, with the resultant loss of 1½ shifts of productive work.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

If it is mandatory that concrete be poured only on day shifts, provisions should be made to use the interim time to bore, provided the BSB is ready to bore.

TIME UTILIZATION

Problem 5 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The remedial work on roads, settling and storage ponds, and work to minimize stream contamination were subcontracted.

CAUSE

The use of subcontractors arose from the inability of the contractor to identify and solve project details before they became a major problem. The equipment and personnel to do the work often were available on the jobsite.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

The contractor should have direct responsibility for all visual and environmental pollution. The equipment mobilized on the jobsite must be used, as much as possible, primarily to support the project and secondarily to improve the site. The site should be a showplace, illustrating that while the BSB does the work faster and safer, it does not pollute the environment.

TIME UTILIZATION

Problem 6 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

A considerable amount of boring time was lost while waiting for parts.

CAUSE

Contractor did not anticipate the high usage of parts, and supplied the warehouse with a conventional number of replacements. The BSB was a new machine without a parts replacement history. A considerable number of replacement and retrofit parts were unique to the BSB and did not interface with the originals.

INTERIM SOLUTIONS

Prime contractor's service supervisor was responsible for both inventory and availability of parts. The supervisor was not kept aware of all parts taken out of stock on other shifts, nor of any major planned maintenance or retrofit projects. The parts problem was improved as the project progressed but not completely solved.

RECOMMENDATIONS

On this project, the time and money saved by increasing BSB utilization through the immediate availability of parts would have more than paid the salaries of one warehouseman per shift. This would have, in addition to improved inventory control:

- o freed the prime contractor's representative from clerical work, permitting him to spend more time assisting in maintenance on the BSB,
- o assured that all the spare and retrofit parts would be interchangeable,
- o improved the planning of major maintenance work, such as replacing a complete flight conveyor assembly.

TIME UTILIZATION

Problem 7 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The concreting cycle time was excessive, averaging 20 hours per cycle.

CAUSE

The BSB was operated in 20-foot cycles that initially required that boring and concreting be treated as separate tasks. During the course of the project, both boring and concreting were to be integrated and the BSB shut down only for actual concrete pouring. This integrated plan was not implemented.

INTERIM SOLUTION

None

RECOMMENDATIONS

- o Eliminate the 20-foot cycles so that concreting will always be independent of boring.
- o Modify the curb ring so that it can be lowered while the BSB is boring and without interfering with the laser beams.
- o Remove the transformer from the galloway so the galloway can be fully utilized as a movable work platform.

TIME UTILIZATION

Problem 8 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The one-half hour preshift maintenance check did not provide the intended low maintenance operation.

CAUSE

The intent was to identify and correct potential problems before they occurred. Since 60 percent of the project time was spent on maintenance, it is apparent that a one-half hour check did not accomplish that goal. Failure resulted from trying to keep inadequate systems operating rather than modifying them to provide satisfactory systems.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

The recommendations in this problem book are made with the intent that all routine BSB maintenance will be performed while the BSB is operating.

TIME UTILIZATION

Problem 9 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Toward the end of the project, the weekly safety meetings deteriorated to a forum for non-safety related complaints.

CAUSE

The project manager usually did not participate in the meetings, so the miners became disinterested.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

The project manager should be required to attend the safety meetings to establish direct communication with the miners, show that management is interested in their general welfare and guide the discussions so that they involve safety topics rather than minor grievances.

TIME UTILIZATION

Problem 10 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The miners were evacuated from the shaft when the large BSB components were being hoisted to the surface. They were given very little productive work to do while they were on the surface.

CAUSE

Management did not provide adequate work directives.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Design the conceptual galloway and BSB so that each could be taken out of the shaft in one shift for further disassembly on surface. This would minimize the ill feelings associated with reducing the number of shifts and the necessity to lay off men based on seniority, not capabilities.

The men should be worked to the day they are terminated, since work concessions prior to termination have a negative effect on their attitude and productivity.

TIME UTILIZATION

Problem 11 of 11

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Back-to-back shift changes precluded any possibility of performing tasks between shifts that could increase the productivity of individual shifts.

CAUSE

This is applicable only after the project went to two shifts per day. Day shift started at 7 a.m. and the afternoon shift at 3 a.m. The consequence was that there was no time between day and afternoon shifts, but eight hours between afternoon and the following day shift.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

When operating two shifts per day, there should be equal idle time (four hours) between shifts. This will permit a shift to work overtime, as required, to complete a boring cycle, to pour a section of concrete liner, or to complete a maintenance task.

It could also increase the BSB availability to bore by permitting the hoistman and mechanics to start one hour early to perform the preshift maintenance and to dewater the shaft. This would have the following benefits, as shown by the following calculations:

(paid)	3 men x 1 hour x 1.5 overtime factor	= 4½ manhours
(saved)	13 men x ½ hour	= 6½ manhours

In addition to the pay savings, it would provide one-half hour of additional operational time, which is an increase of 8.3 percent (0.5/6.0 hours).

MAINTENANCE

Problem 1 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

With the exception of the drive motors, the BSB system had no redundancy or reserve capacity, so the BSB had to be shut down for all maintenance.

CAUSE

The overall BSB design did not provide the needed redundancy.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Design and build redundancy into both the hydraulic and lubrication systems so that maintenance can be performed while the BSB is boring.

MAINTENANCE

Problem 2 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

During long shutdowns, the shaft water had to be pumped out to prevent the accumulating water from contaminating the main bearing and lubricating oil or grounding the electric drive motors and controls.

CAUSE

Ground water seeped through the concrete lining and/or from the unlined wall area at the shaft bottom. No automatic pumping facilities were available.

INTERIM SOLUTIONS

When the BSB was operational, the water was kept to acceptable levels because inflow was less than that required for boring. During the long shutdowns, such as the two-week Christmas shutdown, a crew worked one shift to dewater the shaft.

RECOMMENDATIONS

Replace the existing two-stage pumping system with a high pressure, air-driven piston pump to automatically pump the water directly to the surface. The pump should be actuated with a float, and both the float and pump suction should be screened to keep out chips and large pieces of muck.

MAINTENANCE

Problem 3 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Many maintenance items were physically difficult to perform on the BSB because of a combination of:

- o lack of working room,
- o high humidity accompanied with dripping water,
- o spilled muck in the work areas,
- o use of hardware incompatible with the conditions encountered,
- o severe wind chilling during the winter months.

CAUSE

The BSB design was inadequate for the operating conditions encountered by the BSB.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

One prerequisite is that the key designers involved in the modified or conceptual BSB design observe at least one sinking cycle performed by a major, hard rock, shaft sinking contractor. Then, for both the modified and conceptual redesigned BSB:

- o make all the work areas free and accessible to work in,
- o design all major wear components so they can be easily removed from the BSB, hoisted to the surface, cleaned/rebuilt/tested/painted and made available as the next replacement,
- o limit downhole work to routine maintenance while the BSB is boring and to the replacement of wear components.

MAINTENANCE

Problem 4 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Only a few of the many operational problems were resolved during the project.

CAUSE

Problems, of all magnitudes, were referred to the prime contractor's home office for review and recommendations. Many of the problems considered serious by site personnel were not addressed by the home office. The problems that were addressed frequently required an extensive time interval before the recommendation reached the site. Furthermore, when the project was terminated, many of the recommendations had not yet been acted upon.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

An improved contractual arrangement with the prime contractor that would make it easier for the DOE to implement improved procedures to alter designs is recommended.

An alternative is to use a construction manager, who would decide how and when operational changes should be made. He would assume total responsibility for project performance and have total control over all subcontractors.

MAINTENANCE

Problem 5 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Replacement components often had missing parts or had parts that were improperly machined or fitted.

CAUSE

Although replacement of components was scheduled in advance, planning sometimes was not complete, and trial assembly of parts often was not done.

INTERIM SOLUTIONS

- o The missing required parts were ordered and the BSB shutdown while waiting for air freight shipments to arrive.
- o The BSB was returned to operational status by replacing the used parts that had been removed, ordering new parts from the factory and making the final changes at a later date.

RECOMMENDATIONS

Hire a warehouseman to:

- o Catalog the inventory on a cardex (or equivalent) system that relates, on sight, the number of parts in stock, location, consumption and ordering points.
- o Order parts and follow with paper tracks through delivery, confirming that the parts delivered are those ordered and in the quantities required.
- o Check each replacement part to insure that it is interchangeable with those in stock and used on the BSB.
- o Preassemble retrofits to insure that all parts interface satisfactorily with one another.

MAINTENANCE

Problem 6 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Considerable maintenance time was spent tightening the wedge bolts used to retain the backloading cutters.

CAUSE

Total cutterhead thrust was opposed by the wedges anchoring each cutter. Retaining bolts kept each wedge in place but did not share any of the thrust load.

When boring, apparently the jarring and shock loading on the wedges caused the bolts to loosen. If not kept tight, the bolts and helicoils (threaded inserts) wore and had to be replaced.

INTERIM SOLUTIONS

As part of routine maintenance, the inside of the cutterhead was washed down, muck cleaned off the cutterhead bolts, and the bolts tightened.

RECOMMENDATIONS

Replace the backloading cutters with cutters that can be installed on the face through an open-face cutterhead. This will distribute the thrust directly to the cutters instead of passively through wedges. This also will eliminate the use of cap screws with threads in the cutterhead and will permit retrofitting with various threaded bolts and nuts to get that combination that would best resist loosening. If required, the nuts could be spot welded to the bolts and burned off when changing cutters.

MAINTENANCE

Problem 7 of 7

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Maintenance work on the BSB required a large compliment of tools that frequently were lost or misplaced.

CAUSE

Design personnel were unfamiliar with underground maintenance requirements. The problem was compounded because those tools missing in the shaft had to be replaced by tools on the surface and lowered in the man cage.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

All nuts, bolts and fittings should be of a few common sizes so that they can be worked on with a minimum number of tools, preferably those a mechanic can carry in his pocket. The heads should be of adequate size so that, in the event of an emergency, they can be removed with a 10-inch pipe wrench, with a cheater if required. Socket head bolts should not be used, since the heads fill with muck, rust and become difficult to engage with the special wrench.

All hydraulic fittings mounted in a manifold should be so distributed that any one can be removed without disturbing the others.

MANPOWER UTILIZATION

Problem 1 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Some of the engineering, practical and industry related skills available on the jobsite were not used in addressing and solving the many project problems.

CAUSE

The prime contractor's management procedures were not structured to take advantage of the available talent.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

A possible solution would be to require the contractor to establish a committee of jobsite engineers, including a government representative, that would meet weekly. The meetings could be chaired for one month by successive members so that one individual, or a group, would not dominate the meetings.

Problems could be discussed, given priorities and assigned to engineering teams for further investigation and recommendations. At designated meetings, the results of the investigation and subsequent recommendations would be discussed. The identified problem with the recommended solution would be submitted in writing to the Project Manager with a copy to the Technical Project Officer. If advisable, the Project Manager could discuss the problem with his supervisors before submitting his written reply to the committee, with a copy to the Technical Project Officer.

This procedure would permit continual, effective evaluation of the progress of the project by the government representative.

MANPOWER UTILIZATION

Problem 2 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

In the last quarter of the project, the miners' interest waned, and the grievances increased.

CAUSE

The miners' conclusion was that:

- o No operational changes were being made to reverse the diminishing performance of the BSB. Consequently, the enthusiasm they had at the beginning of the project turned into negativism.
- o Their many recommendations on methods to increase their performance and the BSB performance were ignored.
- o They (the miners) and first line supervision did not have satisfactory communication with upper management.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

- o All miners' recommendations should be in writing, placed in a suggestion box and reviewed by management. Each recommendation which the miner takes the time to write should receive a written reply. The originators of suggestions used should be given an appropriate honor or reward.
- o Shifts should continuously compete with each other, and the one giving the best performance over a period of time, possibly monthly, should be acknowledged and appropriately rewarded.
- o Performance charts and statistics should be posted on the bulletin board to arouse and maintain worker interest in the project.

MANPOWER UTILIZATION

Problem 3 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Direct line supervision had minimum communication with project management.

CAUSE

- o Each level of management was physically segregated so that discussions were not spontaneous but had to be planned.
- o Information was usually exchanged through an intermediary.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

- o Management should hold informal, round table discussions with all salaried personnel at frequent intervals, possible during lunch hour.
- o Shifts should be rotated so that management will have periodic direct contact with all miners and shift supervisors.
- o Upper management should visit each work area at least once per day.

SAFETY

Problem 1 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The emergency hoist had direct access only to the top deck of the galloway.

CAUSE

There were no cutouts in the galloway to permit passage of the emergency hoist cage to the lower levels.

INTERIM SOLUTIONS

A rope ladder was installed between the BSB and galloway. In the event the emergency hoist had to be used to hoist a stretcher from the BSB, an attempt would have been made to hand guide the cage through the galloway skip or mancage wells.

RECOMMENDATIONS

Unlike the usual shaft excavation that uses only one hoist for muck and personnel, the BSB project had two. One was for hoisting personnel and the other for hoisting muck.

When a skip hoisting system is used, mancages should be installed above the skips, permitting the skip hoist to be used for hoisting personnel. Both hoists would go through the galloway, reaching the BSB. One would serve as a standby for the other.

When using pneumatic conveying, skip hoisting would be eliminated, and a separate emergency hoist would be required.

SAFETY

Problem 2 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The BSB operated in a 25-foot diameter work space with a hostile environment. Unlike a mine where one can attempt to hide from an event or a series of events that form a disaster, the shaft provides no place to go.

CAUSE

The only possibility of leaving the shaft is to be hoisted to the surface. The hoist is usually not available immediately when needed, and if available, it does not have the required capacity to hoist all the miners at one time.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Provide a safety capsule to house the miners temporarily until the danger subsides or they can be rescued. Such a capsule could be the operators cab that would use either surface pressurized air or recirculated cardoxide air to sustain life.

SAFETY

Problem 3 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

As the mancase approached the desired landing, the miners opened the cage door, gripped either the galloway or the BSB and rotated the cage so that the door would line up with the landing.

CAUSE

The mancase was unguided and free to rotate.

INTERIM SOLUTIONS

Rotation of the cage was made easier by installing a swivel between the rope and the cage.

RECOMMENDATIONS

On the modified BSB, install interlocks on the mancase door so that it cannot be opened until the cage stops at a landing. Enclose all openings under the bonnet with 3/4-inch expanded lath to prevent the miners from extending their hands beyond the cage. On the conceptual redesign of the BSB, use a cage that is guided by rails mounted on the shaft walls to prevent cage rotation and provide a broken rope safety.

SAFETY

Problem 4 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The BSB would not meet mining codes in all the states.

CAUSE

The BSB was designed and built with limited contact with the regulatory agencies. Prior to BSB startup, several variances had to be obtained.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

While the BSB is in storage, sketches and a detailed description of the proposed modified version should be prepared and mailed to all applicable federal and state agencies for their comments. South Africa, the United Kingdom, West Germany and Canada should also be involved because some of their codes differ from ours. Once the comments are compiled, suitable revisions can be made to the original drawings.

SAFETY

Problem 5 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The man cage did not have a slack or broken rope safety device for stopping the cage.

CAUSE

The man cage was constructed similar to a sinking bucket in which the crosshead remained on the gallows as the single rope-supported man cage went to the BSB.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Some states will not permit this system to be used for hoisting personnel. If the modified BSB is to be used in those states, the system will have to be abandoned and the recommended conceptual design or equivalent used.

The conceptual redesign BSB should use cage guides bolted to the shaft liner and a man cage with a slack and broken rope safety. The hoisting system would not require any hoistman, since it would be remotely controlled from the cage by trailing control cable to the hoist.

SAFETY

Problem 6 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The sliding door on the man cage would hang up, making operation difficult. As a result, the miners occasionally left the door open when being hoisted to the surface and almost always when moving between the BSB and galloway.

CAUSE

Muck built up inside the tracking mechanism or sometimes the door was sprung out of alignment from handling equipment and parts. Most sliding doors used underground have the same problems.

INTERIM SOLUTIONS

Contractor made frequent repairs to keep the door free.

RECOMMENDATIONS

Replace the sliding door with a double inward folding or counter-balanced upward swinging door. Both are easy to interlock and would not injure the miners within, if the landing interlocks were bypassed and the cage hoisted with the doors open.

SAFETY

Problem 7 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

There was no independent access from the BSB to the galloway.

CAUSE

An oversight in design.

INTERIM SOLUTIONS

Manhoist was used to move personnel and material between the BSB and galloway. After the project was started, MSHA required that a rope ladder be installed to interconnect the two. Unfortunately, the ladder was rarely used because it would tend to tip the climber backwards, making both ascent and descent difficult. When the galloway and BSB were operating close together, a wooden ladder was occasionally used for access.

RECOMMENDATIONS

Install an approved double-rope hoist on the galloway to service the BSB. This slow-speed hoist would be operated by the miner from within the cage through a trailing cable to the hoist. One wire rope will support the cage and the other will be the safety that engages the cage when the support rope has slack or breaks. The installation is relatively simple and inexpensive.

SAFETY

Problem 8 of 8

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Ventilation fans often were turned off in the winter, creating a possible safety hazard and resulting in one citation from MSHA.

CAUSE

The fans were circulating 20,000 to 30,000 CFM of surface air, causing uncomfortable wind chilling. This was compounded by ground and boring water that dripped from the BSB platforms.

INTERIM SOLUTIONS

Water was shedded where feasible. However, miners continued to shut off the exhaust fan whenever they worked in the cutterhead or inner tower. Rotary red lights were installed above each fan to show that the specific fan was operating.

RECOMMENDATIONS

Heat the air with fossil fuels or heat generated by the surface plant, such as the heat of compression from vacuum pumps (if used for the muck pickup) and/or compressors (for pneumatic conveying).

SETTLING PONDS

Problem 1 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The settling ponds overflowed after heavy rainstorms.

CAUSE

The settling ponds were situated in a basin that trapped and accumulated water runoff from the adjacent slopes.

INTERIM SOLUTIONS

A subcontractor constructed diversion berms:

- o north of No. 1 pond to divert water into a ditch along the main site road
- o west of No. 3 pond to divert water into the drains

The project crew constructed drains west and east of No. 5 pond to catch and divert water into the main stream.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum muck pickup to minimize the water used while boring. Construct emergency settling pond to handle temporary excessive inflows of water to the shaft until such inflows could be grouted.

SETTLING PONDS

Problem 2 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The construction and arrangement of the settling ponds resulted in leakage which contaminated the natural stream flowing through the area.

CAUSE

- o The corrugated culvert that bypassed the marsh water under No. 3 and 5 ponds leaked and discharged a mixture of marsh and contaminated water into the stream.
- o No. 5 dam leaked around the corrugated culvert pipes.
- o No. 3 settling pond seeped through a porous shale formation, under No. 5 dam and pond, and into the stream.
- o No. 5 pond overfilled, spilled over the riser pipe, and flowed into the stream.

INTERIM SOLUTIONS

- o Snaked plastic pipes through the diversion culvert to contain the marsh water.
- o Grouted No. 5 dam around the perimeter of the culvert pipe and in the porous shale formation.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum pickup that will not generate the excesses of water experienced on this project.

SETTLING PONDS

Problem 3 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The method finally used to dispose of the flocculant from No. 1 and 2 settling ponds added \$150 per foot to the boring cost of the project.

CAUSE

To dispose of the flocculant, it was:

- o clammed from the pond with a crane,
- o mixed in a paddle wheel agitator, using a ratio of 1 cubic yard of flocculant with one 60-pound sack of hydrated lime and fly ash,
- o the solids were conveyed into a dump truck and transported to the No. 6 disposal site.

INTERIM SOLUTIONS

Original method was to clam the flocculant into a dump truck and mix with the larger muck in No. 4 muck storage pond. Unfortunately, the water would drain into and further contaminate No. 3 pond, follow the porous shale formation under No. 5 pond and contaminate the stream.

RECOMMENDATIONS

Replace the mechanical muck pickup with vacuum pickup that would require considerably less makeup water.

STREAM CONTAMINATION

Problem 1 of 1

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Fines would not settle from the water in No. 1 settling pond. This was water that drained from the hoisted muck.

CAUSE

Tests indicated that most of the fines were minus 400 mesh. Jobsite experience confirmed that the settling ponds did not offer sufficient residency to settle the fines.

INTERIM SOLUTIONS

Increased the size of the settling ponds. The ponds were dewatered in cycles by allowing them to fill, adding alum and mixing with the water to flocculate the fines. The supernatant was later pumped into the stream. The process normally required more than 24 hours.

RECOMMENDATIONS

Replace the mechanical muck pickup with a vacuum pickup that requires less makeup water and muck with little free moisture.

COMMUNICATION

Problem 1 of 1

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Flow of information between companies on the jobsite was very limited.

CAUSE

All operational information was collected, reviewed and approved by various personnel of the operating contractor before releasing the information.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Award future field trial work to an experienced construction manager whose functions would include the collection, evaluation and distribution of all data. The rough data and its evaluation should be compiled in a weekly report that is made available to everyone associated with the project, including the miners. The report should include the scheduled performance so that the readers could compare actual versus expected performance. Inter-company meetings should be held on a regular basis to discuss goals and achievements.

ORGANIZATION

Problem 1 of 1

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Project performance dropped from a peak of 72 feet bored in a month to an average of 26 feet per month.

CAUSE

Lack of communication between the prime contractor, the operating contractor and the government sponsor resulted in:

- o a lack of long-range planning,
- o inability of the operating contractor to react quickly and positively to everyday problems on the jobsite,
- o hesitancy of the operating contractor to assume responsibility for the needed modifications.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

On future projects, use an experienced construction manager as the prime contractor to provide overall project management and coordinate all the subcontractors' efforts with a single point of authority and responsibility. The construction manager should:

- o Screen and select subcontractors most qualified to do specific tasks at competitive costs.
- o Continuously monitor their work for safety, efficiency and ability to respond to problems.
- o Replace them if their work was unsatisfactory.
- o Purchase and/or rent equipment at competitive prices.

- o Monitor maintenance and warranty repairs to assure that the conditions of rental and purchase are met.
- o Provide engineering services as needed to assure that problems are identified and resolved.
- o Control the ordering, receiving and inventory of parts.
- o Perform quality control to assure that parts fit prior to actual installation.
- o Collect all data and evaluate it for performance and boring costs.
- o Provide the necessary liaison to insure full cooperation of all parties involved.
- o Insure that DOE objectives are met.

GROUTING

Problem 1 of 1

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Minor water inflows were encountered in the shaft.

CAUSE

Grout holes intersected while boring, indicating very little communication of the grout into the formations. The grouting program was well executed, but the formation was very competent and, therefore, not susceptible to good grouting results.

INTERIM SOLUTIONS

Two significant inflows of water encountered while boring were spot grouted.

RECOMMENDATIONS

No change is recommended. Pregrouting should be used where effective, with subsequent spot grouting as required.

CONCRETE LINING

Problem 1 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

BSB shutdown time after a concrete pour typically was about four hours to clean spilled concrete from the BSB.

CAUSE

Concrete spills originated from:

- o "lubricating" the slickline prior to pouring concrete
- o freeing plugged slicklines
- o flushing out the slickline after a pour

The spilled concrete would catch on the perimeter of the BSB decks.

INTERIM SOLUTIONS

The spills were dumped into the hoppers and sugar was added to retard setting. There were times when the sugar was ineffective and the concrete had to be chipped out. The concrete that landed on the platforms had to be chipped off, piled near the mancage, loaded into a bucket temporarily installed on the mancage to hoist both spilled muck and concrete to the surface. There was no practical means of dumping the chipped concrete into the face for removal by the muck system.

RECOMMENDATIONS

Make the modified BSB self-cleaning by eliminating the ledges that caught the muck and concrete. Keep the BSB clean by using both low and high pressure water sprays.

The conceptual redesign of the BSB should have a minimum of platforms, be self-cleaning and have all the fragile components and hardware packaged and installed so they would not be damaged by high pressure water washing.

CONCRETE LINING

Problem 2 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Honeycombing in the concrete liner increased to about 30 percent of each pour after 450 foot depth. Occasionally, the honeycombed sections were so incompetent that the aggregate could be dug out by hand.

CAUSE

Concrete was trucked from Bessemer, some 25 miles or 1 hour away. Waiting time to pour the delivered concrete was frequently in excess of one-half hour, so the concrete was starting to set before placement began. These delays were further compounded when the concrete had insufficient slump and would plug the slickline. Also, the remaining 10 feet of forms had to be lowered in the middle of the pour. The poor quality of the placed concrete was reflected in the competency of the liner.

INTERIM SOLUTIONS

- o Hand patched the honeycombed sections of liner.
- o Used air vibrators to move and compact the concrete. The vibration gave negative results.
- o Changed the mix and increased the slump toward the end of the project. The plugging ceased, honeycombing decreased, and the pours were made in 20-foot monoliths.

RECOMMENDATIONS

Periodically, the liner should be cored and the cylinders tested for compressive strengths. It is important that the concrete used be tailored to that specific shaft, the materials used in the mix, methods of delivery, and the manner of placement.

CONCRETE LINING

Problem 3 of 3

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Most of the 20-foot concrete pours were made in two, 10-foot lifts.

CAUSE

The concrete was too viscous to flow laterally from the pour windows, so it was distributed over the top 10-foot section of the form.

INTERIM SOLUTIONS

Changed to a concrete mix with less coarse aggregate and more sand, cement and water. The slump was increased from 4 to 7 inches, which allowed the 20-foot pours to be made as a monolith.

RECOMMENDATIONS

Specifications should limit the number of cold joints permitted and the amount of time the mixed concrete can be held before being poured. These variables affect the quality of the liner and should be closely controlled.

MOBILIZATION

Problem 1 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The front shield segments had to be installed in one specific sequential order.

CAUSE

Designers failed to consider that, when assembled in the shaft, the segments had limited horizontal room.

INTERIM SOLUTIONS

When the problem of assembly was noted, the sequence was changed and noted for future reference.

RECOMMENDATIONS

Eliminate the front shield on the conceptual redesign of the BSB. The massiveness, weight and difficulty of installing the front shield on the BSB in the shaft collar far outweighs the limited safety gain.

MOBILIZATION

Problem 2 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Rental cranes were required to:

- o unload all project equipment from trailers,
- o mobilize the BSB in the shaft,
- o hoist muck until all support systems were installed,
- o assemble the headframe.

The cost of crane rentals would be prohibitive in many remote areas.

CAUSE

Unlike the equipment for an excavated shaft that can be mobilized with the contractor's boom truck, the BSB and its complementary equipment were massive and required large cranes.

INTERIM SOLUTIONS

The cranes were rented during mobilization. Fortunately, they were available from Birmingham, within 50 miles of the jobsite.

RECOMMENDATIONS

On the modified BSB using a skip hoisting system, continue renting cranes as needed. On both the modified and conceptual redesign BSB using pneumatic conveying in place of skip hoisting to move rock to surface, eliminate the headframe and use a permanently installed stiff leg derrick crane to perform the tasks of the rental crane, shaft service and yard crane.

MOBILIZATION

Problem 3 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The BSB could not be mobilized in the shaft collar as planned.

CAUSE

Shaft collar that was to be used as a starting tube for the BSB provided questionable clearance for the assembled cutterhead. As a consequence, the BSB was assembled in the shaft rather than on the surface.

INTERIM SOLUTIONS

The tight places were enlarged with pneumatic chisels.

RECOMMENDATIONS

Forming a 24'-5" inside diameter shaft collar to the tolerances required for the present BSB is difficult and unnecessarily expensive because of the considerable internal bracing required. The collar should be constructed of bolted concrete segments, backfilled with tamped, stripped overburden, and grouted to seal any water leaks.

MOBILIZATION

Problem 4 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Time required to assemble and erect the headframe was excessive.

CAUSE

The headframe weighed 110 tons and consisted of back legs (30 tons), front legs with dumping scrolls (45 tons) and a head sheave structure (35 tons). Assembly required some 2,000 bolts and was designed as a permanent headframe.

INTERIM SOLUTIONS

Total time and hazards of men working at heights were reduced by preassembly of components on the ground and hoisting them into position with a crane.

RECOMMENDATIONS

The BSB headframe will be required when skip hoisting. The design should be modified so that the headframe can be mobilized with a procedure similar to a sinking headframe or an oil field drilling rig with similar hook load capacity. Assembly would take place with a minimum number of bolts and pins.

DEMOBILIZATION

Problem 1 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Time required to demobilize the site was as follows:

	<u>Working Days</u>
Galloway	12
Blind Shaft Borer	22
Strip Shaft	5
Headframe	11
Surface Plant	8
Loading Equipment on Trailers	<u>8</u>
TOTAL	66 (3 months)

CAUSE

Complexity, massiveness and sophistication of the equipment.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Demobilization time of the modified BSB would be about the same as for the existing BSB. The modifications were directed toward achieving maximum performance with minimum modification costs. Conversely, the conceptual redesigned BSB will incorporate both the performance of the modified BSB and rapid demobilization capability. The galloway and conceptual BSB can be hoisted from the shaft in one shift and disassembled into trailer-size components. Since the conceptual BSB will be using pneumatic conveying to move the muck to surface, the project would not require a headframe. Estimated demobilization time is two weeks.

DEMOBILIZATION

Problem 2 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The original shaft cover was inadequate for removing the galloway and BSB from the shaft.

CAUSE

The shaft cover was designed for hoisting muck and personnel while the BSB bored the shaft. No provisions were made to pass any material larger than the doors.

INTERIM SOLUTIONS

The first shaft cover modification was to remove the divider between the skip doors and replace the two small doors with one large door. Wheels guided by rails were installed so that the door could be rolled back as required. When the door proved inadequate, the cover was reinforced and the door was enlarged to half the cover size. The large door (half cover) was set aside with the crane when large components were hoisted.

RECOMMENDATIONS

Unless other provisions are made, most items that go in or out of the shaft use the shaft cover as an intermediate transfer point. Consequently, the cover must be strong enough to support the largest load imposed. The individual skip and mancage doors should be retained for day-to-day operations, but the entire shaft cover should be mounted on railroad wheels guided by rails to provide full opening for removal of the large components. The cover should be hinged parallel to the structural beams so that it could be folded, loaded and transported as a legal trailer load. If the stiff-leg derrick is used to bring material from the yard for lowering into the shaft without using the cover as an intermediate transfer station, the cover could be made lighter.

DEMOBILIZATION

Problem 3 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

When the operator deck was removed from the BSB, the miners had to be evacuated from the shaft whenever hoisting was done.

CAUSE

The operator deck was the only protective cover for miners in the shaft during mobilization and demobilization.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

The modified BSB will have the same mobilization and demobilization problems. In contrast, the conceptual redesigned BSB would be hoisted from the shaft in one piece and disassembled into trailer-sized components on the surface.

DEMOBILIZATION

Problem 4 of 4

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Miners had to be evacuated from the shaft when heavy components of the BSB were hoisted.

CAUSE

There were no cutouts in the shaft where the miners could seek cover while the components were hoisted to surface.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Time for mobilization and demobilization of the modified BSB will be approximately the same as for the existing BSB because no changes will be made to the actual overall design and dimensions. The conceptual redesigned BSB will be hoisted from the shaft in one piece using a stiff-leg derrick crane. Disassembly will be on surface with the BSB broken down into trailer-sized components.

MOTHBALLING

Problem 1 of 1

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Cost of processing the DOE-owned equipment was excessive.

CAUSE

The equipment was removed from the site so that preservation procedures could be done more efficiently outside the jurisdiction of the miner's union. After demobilization, the miners were terminated but later had to be recalled to complete disassembly of the BSB and galloway and to load the parts on trailers for shipment to the new site about 50 miles away. Packaging and preservation was performed by a third subcontractor, using the original operator as a supervisor with another union's temporary help.

INTERIM SOLUTIONS

All the equipment was multi-handled as follows:

- o temporarily stored behind the site security fence
- o disassembled into legal-size loads
- o loaded on trailers for transportation to the packaging site
- o unloaded in a staging area
- o prepared for long-term storage
- o loaded on trailers for delivery to the storage site

RECOMMENDATIONS

Eliminate the double cost of rental cranes, labor and freight to the new site by performing all the packaging on the project site with the same personnel who had worked on the BSB for two years. Establish an assembly line so that each piece removed from the shaft would be steam cleaned, sand-blasted, painted, cataloged and loaded on a trailer for the destination. The modified BSB would require similar, but not as extensive, preparation for transportation to a new site. In contrast, the conceptual redesigned BSB would have no critical interfaces and could be shipped with only minimal cleanup.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 1 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The lower elbows suffered high wear from abrasion by the rock being lifted.

CAUSE

Relative sharp radius elbows were required to retrofit the original BSB. The test elbows were fabricated from mild steel.

INTERIM SOLUTIONS

Repaired the hole and built up the inner surface with abrasion resistant welding rod as required.

RECOMMENDATIONS

Use a deep "W" cutterhead which would require less severe bends. To further reduce wear, use abrasion resistant, high-chrome, white, cast iron elbows. An alternative is a conical cutterhead with near center muck pickup and no elbows.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 2 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The rotary feeder frequently plugged with cohesive muck.

CAUSE

Cohesive muck built up in the pockets of the rotating assembly because insufficient centrifugal forces were generated to make the assembly self-cleaning.

INTERIM SOLUTIONS

Minimized operation time with sticky muck, maintained 10 percent moisture content, and continuously removed the excess fines from the system.

RECOMMENDATIONS

Provide for water addition at the feeder when cohesive muck is produced.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 3 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Oversized muck occasionally jammed the rotary feeder.

CAUSE

There was insufficient momentum in the rotating pocket assembly to break large pieces of muck when they were trapped against side jaw assembly.

INTERIM SOLUTIONS

Adjusted feeder pocket rotation speed upward until the limits of the hydraulic supply were reached (60 rpm). Also, the operator immediately reversed rotation of the feeder when a jam occurred.

RECOMMENDATIONS

Operate the feeder at 60 rpm (higher if better performance is obtained) which minimizes the level of muck in each pocket and increases the energy available for breaking trapped muck.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 4 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Muck built up in outer portion of primary cyclone inlet.

CAUSE

The horizontal inlet was of larger cross-section than the upcast pipe. Reduced velocity permitted muck to drop out of suspension before entering the cyclone body. Periods of reduced airflow and lower air velocity further compounded the problem.

INTERIM SOLUTIONS

The operator delayed lifting of the muck until the blower speeds were above 1,800 rpm. Inspected and cleaned the cyclone inlet as necessary.

RECOMMENDATIONS

Revise the cyclone inlet size to eliminate the change in cross-sectional area and shorten the inlet length so that any muck dropping out of suspension will fall into the cyclone. An alternative to the cyclone is the use of a dust box in conjunction with a muck velocity killer. The dust box should have a large cross-section with significantly reduced air velocity to allow the finer material to separate from the air stream.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 5 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Some dust reached the blowers in spite of the high efficiency cyclone.

CAUSE

Air leakage through the rotary airlock feeder, even when stationary, was sufficient to disrupt the cleaning efficiency of cyclone.

INTERIM SOLUTIONS

Used plywood to seal the bottom of the airlock feeder when operating the system and emptied the fines between test runs.

RECOMMENDATIONS

Retain high efficiency cyclone but equip it with a dual gate discharge system which will provide a continuous and positive seal.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 6 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The telescoping pipe section of the pickup head froze because of muck wedging between inner and outer pipes.

CAUSE

Leading edge of the inner pipe caused buildup of muck between the pipes where clearance was tight.

INTERIM SOLUTIONS

The leading edge of the inner pipe was tapered to act as a scraper, thereby removing muck buildup. Clearance between the pipes was increased to reduce friction when small muck particles were trapped. Clean air was bled into the annular space between the pipe sections for continuous cleaning of the telescoping joint.

RECOMMENDATIONS

Use the modified telescopic joint as a guide for building the operational unit.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 7 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The operator experienced poor control of the muck pickup rate with the fixed position head incorporating a variable throat.

CAUSE

Raising the throat plate and rear bypass flap did not sufficiently reduce pickup head air velocities to prevent muck pickup.

INTERIM SOLUTIONS

Muck was cleared from the vicinity of the pickup head, which was comparable to raising the BSB off the face.

RECOMMENDATIONS

Use a pickup head mounted on a telescoping pipe section, thus allowing the pickup head to be quickly raised from the face.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 8 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The fixed pickup may be subject to possible damage when the BSB is dropped on the face or when it encounters either oversize muck or a loose cutter during boring operations.

CAUSE

Pickup head operates within two inches of face and is subject to impact loadings.

INTERIM SOLUTIONS

None

RECOMMENDATIONS

Use a vertically pivoted telescoping joint above the pickup head. The pivot will protect the pickup head in case the BSB is dropped on the face, and the telescoping joint will permit some movement of the pickup head, thus reducing the severity of the impact with oversized muck.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 9 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Striker plate on the rotary feeder side jaw assembly broke.

CAUSE

Striker plate was mounted on three spacers which allowed flexing as large rocks and steel scrap were caught between the rotating assembly and side jaw assembly.

INTERIM SOLUTIONS

The breakouts were cleaned and the striker plate remounted with longer bolts.

RECOMMENDATIONS

Mount striker plate flush on side of the jaw assembly and revise feeder top plate for easier replacement of striker plates.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 10 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Existing primary cyclone requires the use of elbows which increase the height the vacuum system must lift the muck.

CAUSE

The muck pipe rises vertically and must bend to match the horizontal cyclone entrance.

INTERIM SOLUTIONS

None, with the exception of using rectangular pipe with replaceable wear backs.

RECOMMENDATIONS

Use a dust box with a vertical inlet and eliminate the rectangular elbows. An alternative would be a combination cyclone dust box with a vertical inlet.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 11 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

Moisture content of the muck was not accurately known.

CAUSE

During the testing, the moisture content varied due to continuous discharge of fines in a slurry and the addition of makeup water and fresh rock.

INTERIM SOLUTIONS

Samples of muck were analyzed for particle size distribution and moisture content. Water was added to the dried samples and appearance of the muck was documented for each one percent increase in moisture content by weight.

RECOMMENDATIONS

Increase the power because the moisture content of the Seattle muck may have been greater than the estimated 10 percent. Additional water will not significantly reduce the capacity of the system in actual usage.

TEST OF VACUUM PICKUP SYSTEM
SEATTLE, WASHINGTON

Problem 12 of 12

OPERATIONAL PROBLEM EXPERIENCED OR ANTICIPATED

The rock (muck) tested in Seattle was unlike that encountered by the BSB in Alabama.

CAUSE

No material was available in the Seattle area similar to the Alabama muck, and the muck shipped from Alabama was primarily fines, with little usable material.

INTERIM SOLUTIONS

Three-inch crushed basalt was used because it was the hardest reasonably similar rock that could be obtained.

RECOMMENDATIONS

The vacuum system design should be increased in power and the maintenance simplified in case the Seattle tests were not truly representative of field conditions.

MODIFIED BSB

An analysis of the BSB problems indicates that some major modifications are required to have a commercially acceptable BSB.

Ideally, the effort should correct all the problem areas; however, this would require an almost totally new design utilizing little of the existing BSB. To make use of the existing BSB and determine what additional problems arise when higher penetration rates are achieved, it is proposed to modify the existing BSB to correct only the major deficiencies. The modification of the existing BSB should be the most cost effective method to demonstrate that satisfactory penetration rates can be achieved.

Two modified BSB's are illustrated. The first utilizes what are felt to be the preferred or more applicable revisions, while the second utilizes revisions that are viable and possibly would be preferred under certain conditions.

The modified design BSB illustrated depicts changes made in two of the four major problem areas. These changes are based on the recommendations made in the section of the cutterhead, muck pickup, hydraulic and lubrication systems. With these changes, the existing BSB could demonstrate that acceptable penetration rates can be obtained and maintained for the entire depth of a shaft. The recommended changes to the hydraulic and lubrication systems do not lend themselves to presentation on the illustrations.

The muck retention on the shaft bottom while using the relatively flat cutterhead on the project in Alabama demonstrated the need for a self-cleaning cutterhead. Some previously used downshaft boring machines utilized conical cutterheads which produced a relatively clean shaft bottom. The deep "W" cutterhead is a modified conical and was selected for use based on the fact that the vacuum pickup system was tested in a similar mode of operation. With either cutterhead, an open face design is required to facilitate operation and maintenance.

The mechanical muck system, as tested during the BSB field trial, proved to be unsatisfactory. Even if the mechanical system was repowered, overall maintenance would still be unsatisfactory. The selection of the vacuum muck pickup system is based on its performance during testing. It is recognized that this vacuum system may have further development problems; but it is a relatively simple system, and modifications are easily made.

The hydraulic system can be significantly simplified when the vacuum and pneumatic muck systems are used. With the exception of the rotary airlock feeder, the hydraulic system will be used only to actuate cylinders and lends itself to an air over hydraulic demand type system.

The lubrication system was simplified to reduce the amount of space required, to reduce the quantity of lubrication oil on the BSB, to provide more positive lubrication, and to significantly reduce maintenance time and costs.

The revisions in these four primary areas will have a favorable impact on other problem areas.

While the modified BSB will be capable of boring a shaft at a reasonable rate, the retention of the present front shield, rear shield, and gripper assembly will cause the cost of mobilization, demobilization and transportation to remain prohibitively expensive. A good test plan for the modified BSB would involve a series of shafts in close proximity where minimum transportation and need for complete disassembly between shafts would not be required.

CONCEPTUAL REDESIGN OF THE BSB

A conceptual redesign of the BSB probably will be required before it will be commercially acceptable. The modified BSB will prove that the actual boring of the shaft is economical, but its current mobilization and demobilization costs indicate that it is not competitive with conventional shaft sinking methods.

Since the testing of the modified BSB is expected to reveal additional problems, the conceptual redesign of the BSB was not attempted. However, recommendations and guidelines for the conceptual redesign of the BSB were prepared.

The vacuum system which has been tested is expected to provide satisfactory muck pickup on the modified BSB. However, a hydraulic (water) primary muck pickup system also should be considered for use on the conceptual redesigned machine. It has not been tested, but it appears to have several advantages. It should clean the face better and require less power for a given amount of muck. There are three possible arrangements for the system:

- o a suction pump that is sized to handle the muck generated
- o a hydrojet pickup head so the pump handles return water and no muck
- o an airlift by itself or in combination with a hydrojet head

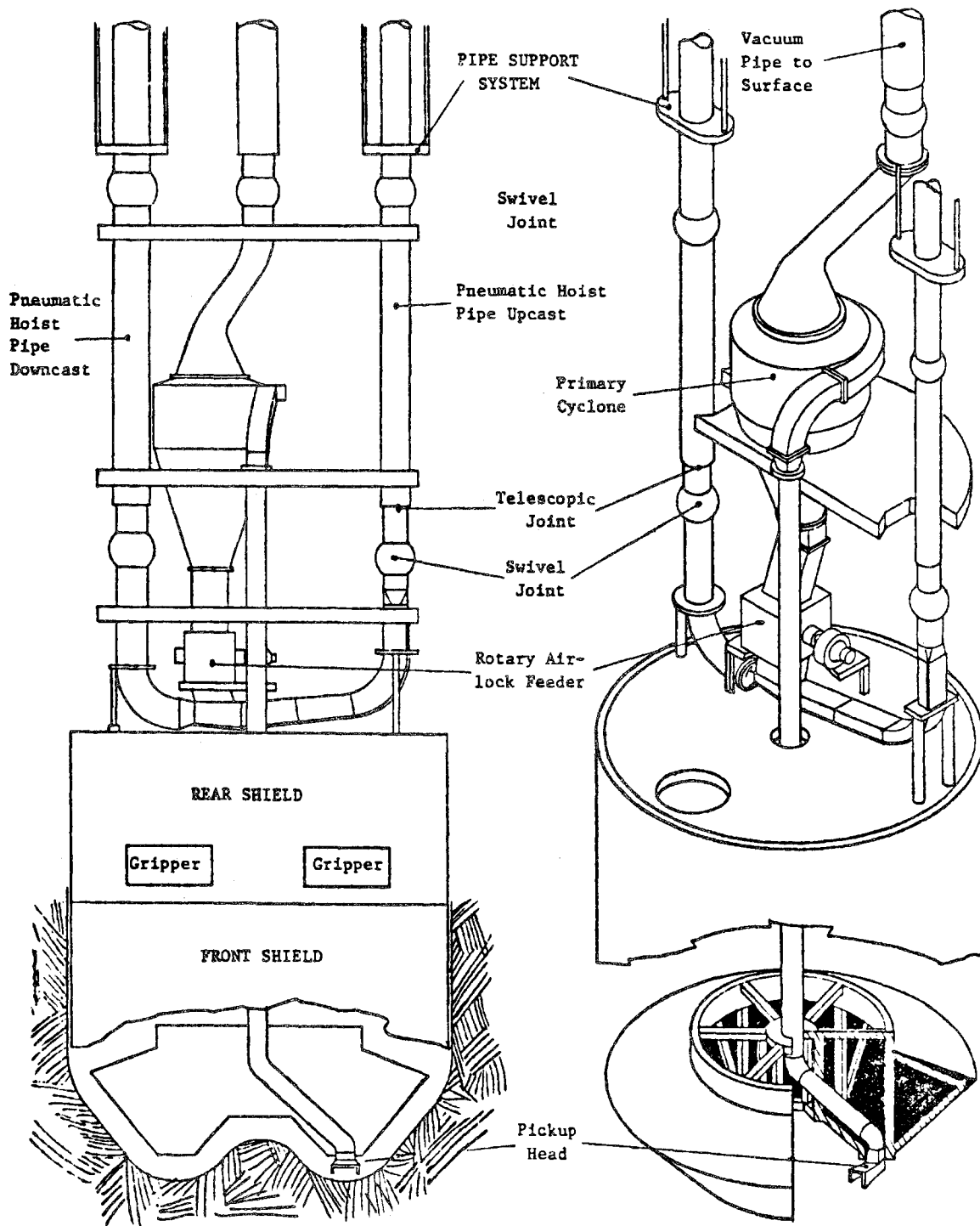
The conceptual redesign should be based on:

- o information obtained and evaluated during the two-year BSB project in Alabama
- o information obtained from testing the modified BSB
- o firsthand knowledge of shaft excavation practices and technology
- o studies of the performances and design features of both the Wirth and Cox blind shaft borers that have bored significant shaft depths

Guidelines recommended for the conceptual redesign of the BSB are as follows:

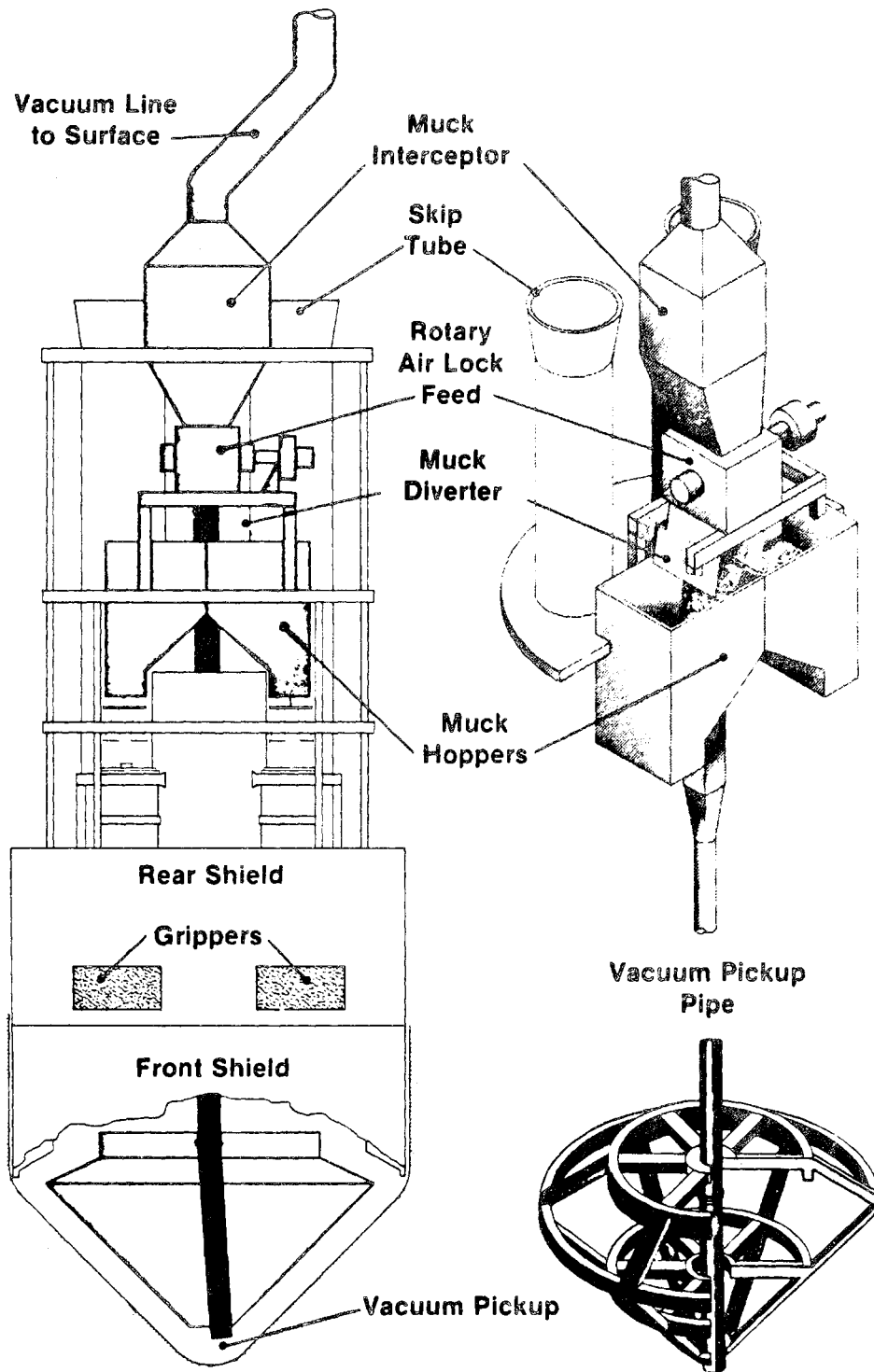
- o Overall simplicity for use in hostile environments.

- o All major components should be under 12 feet in width so that they can be legally transported by truck in any state in the USA.
- o Mobilization after the components arrive on the site should take approximately one week. Initial assembly should be on the surface and the assembled BSB then lowered into the shaft collar. Demobilization should be the reverse.
- o Both the BSB and galloway should be capable of being hoisted from the shaft in one shift without removal of the ventilation or service lines. This will permit major repairs to be done on the surface.
- o All components should be proven on the modified BSB or tested in comparatively more demanding conditions.
- o Major components should be replaceable with new or rebuilt units in less time than required to make the repairs underground.
- o The BSB should give instantaneous boring rates of 5 feet per hour, maintain 3 feet per hour and average 25 feet per day while sinking each shaft. These are minimum figures. Considerably higher figures may be possible.
- o The shaft lining system should be totally independent of boring.
- o Where practical, systems other than the cutters should have redundancy so that all maintenance can be performed while the BSB is boring.
- o The BSB should be a universal shaft contractor's tool capable of economically boring shallow and deep shafts for both coal and hard rock mines, meeting the mine owner's requirements.
- o The cutterhead should be self-cleaning and of open design for access to the cutters and the face.
- o The primary muck pickup system should be interchangeable between vacuum and hydraulic (water) to meet changing shaft requirements.
- o The contractor should have the option of using either pneumatic hoisting or skip hoisting to convey the muck to the surface.



MODIFIED BSB
WITH DEEP W CUTTERHEAD

Figure 13



MODIFIED BSB
WITH ALTERNATE SYSTEMS

Figure 14

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