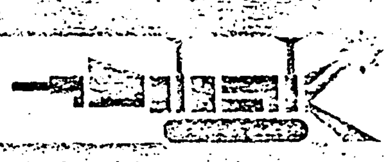
DEMONSTRATION OF SHIELD - TYPE LONGWALL SUPPORTS AT YORK CANYON MINE OF KAISER STEEL CORPORATION

Final Technical Report A

Contractor - Kaiser Steel Corporation

Date Published - April 1980

Contract No. - U.S.D.O.E.EF-74 - C - 01 - 9067
(Formerly U.S.B.M. S0144066)



U. S. Department of Energy
Assistant Secretary for Energy Technology
Division of Fossil Fuel Extraction
Mining Research and Development

DOE/ET/12530--T1

DEMONSTRATION OF SHIELD-TYPE LONGWALL SUPPORTS AT YORK CANYON MINE OF KAISER STEEL CORPORATION

FINAL TECHNICAL REPORT A

RODNEY G. LAWRENCE
ROBERT KING

KAISER STEEL CORPORATION
OAKLAND, CA 94666

DATE PUBLISHED - APRIL 1980

BIBLIOGRAPHIC DATA SHEET	1. Report No. ET-74-C-01-9067	2.	3. Recipient's Accession No.

4. Title and Subtitle	5. Report Date
Demonstration of Shield-Type Longwall Supports at York Canyon Mine of Kaiser Steel Corporation	April 1980
	6.
7. Author(s) Rodney G. Lawrence, Robert King	8. Performing Organization Rept. No.
9. Performing Organization Name and Address Kaiser Steel Corporation General Offices, Kaiser Center 300 Lakeside Drive Oakland, CA 94666	10. Project/Task/Work Unit No. 11. Contract/Grant No. ET-74-C-01-9067
12. Sponsoring Organization Name and Address U. S. Department of Energy Mail Station RB206 Washington, D.C. 20545	13. Type of Report & Period Covered Final 14.

15. Supplementary Notes

16. Abstracts

This report represents work on a program that was originated by the USBM of the Department of the Interior and was transferred to the Department of Energy on October 1, 1977. A demonstration with the Government funded Hemscheidt 320 HSL caliper type shield supports was conducted at three longwall panels of Kaiser Steel Corporation's York Canyon Mine. The purpose of this longwall demonstration was to provide the U.S. coal industry with information on all aspects of shield longwall mining in high seams.
The demonstration provided a working model for the coal industry and during the project, 350 people from the industry, schools, and government agencies visited the demonstration. They were provided with a first hand knowlege of a working shield longwall.
The demonstration showed that the control of large coal lumps may be a problem in the mining of coal seam thicker than 8 feet.
Mining with sheild type supports provided good working conditions and a safe working environment. The shield require very little maintenance and have a high mechanical availability.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	UNCLASSIFIED	193
	20. Security Class (This Page) UNCLASSIFIED	22. Price

FORM NTIS-35 (10-70) USCOMM-DC 40329-P71

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

PAGE

LIST OF PHOTOGRAPHS

LIST OF TABLES

APPENDICES

ABSTRACT

Kaiser Steel Corporation, under the direction of the Government, conducted a Shield Longwall demonstration which consisted of mining three longwall panels with Hemscheidt 320 HSL caliper type shields. The purpose of this longwall demonstration was to provide the U. S. coal industry with information on all aspects of shield longwall mining in high seams.

The demonstration provided a working model for the coal industry. During the project, 350 people from the industry, schools, and government agencies visited the demonstration. They were provided with a first hand knowledge of a working shield longwall.

The demonstration showed that the control of large coal lumps may be a problem in the mining of coal seams thicker than 8 feet.

Mining with shield type supports provided good working conditions and a safe working environment. The shields require very little maintenance and have a high mechanical availability.

When compared to other chock type longwalls, the shield type longwall provided better production, safety record, roof control, and lower costs per ton than the chock type longwall panels.

The demonstration also pointed out the weaknesses of longwall mining. A reliable and efficient system for dust suppression for high production longwall systems needs to be developed.

EXECUTIVE SUMMARY

Although self advancing shield longwall mining has been practiced in European countries for about 25 years, it is a relatively new concept to the U. S. coal industry. There were a few scattered chock type longwalls in the United States prior to 1975, but there were no operating shield longwall panels in the U. S. before 1975 when the contract was negotiated.

It was the important task of this longwall demonstration project to educate the coal industry on all aspects of shield longwall mining. The demonstration site also provided a place where visitors from the industry, government, and mining schools could come to acquire a first hand knowledge of a working shield longwall face. Prior to 1975, Germany or Australia were the closest operating shield longwalls which could be visited.

The shield longwall panels operated in high seam western coal conditions. Two of the panels had good roof conditions whereas the third panel had extraordinarily poor roof conditions. The demonstration panels would mine through geologic fault zones.

The demonstration lasted for 42 months and three demonstration panels were mined. These shield panels were compared with chock panels and another shield panel which operated at the same time as the demonstration panels. Results of production, safety, roof control, costs, and ventilation were compared with the other longwall panels.

The demonstration pointed out the merits and shortcomings of shield longwall mining. The shields are rugged and dependable because of superb engineering and rugged design. The shields themselves had an availability of 99.4%. The face conveyor was the weak link in the longwall system with a 92% availability. The overall longwall face equipment had an availability of 76.5%.

The productivity, safety, and resource recovery definitely increased from continous or conventional mining methods. Productivity, roof control, and safety was better for the shield longwalls than for the chock longwalls.

An effective method to consistantly keep the respirable dust levels within compliance has not yet been developed.

The shield longwall demonstration could not be called anything but a complete success. It accomplished the objectives which it set out to accomplish. It provided a working model for the coal industry. During the project, 350 people visited the demonstration site.

There are now approximately 75 operating longwalls in the United States. Whether or not this demonstration had any influence on the coal industry to purchase shield supports for the longwalls is unknown. But there is no doubt that the problems involved in operating longwalls was made easier from the experience provided by this working model.

Numerous reports on shield longwall mining have been published prior to this report. This is because of the length of this project. There does not seem to be any major differences in this report but rather, this report seems to enhance and complete other publications.

ACKLEDGEMENTS

The authors are grateful for the cooperation of the U. S. B. M., D. O. E., and the Colorado School of Mines in the preparation of this report. In particular, we wish to thank David Wisecarver, Timothy Hackett, and Thomas Morgan, all of the U. S. B. M., Richard Markley, and Jasinder S. Jaspal of D. O. E., C. S. Stewart, and Dr. Donald W. Gentry of Colorado School of Mines. Many others too numerous to mention, provided invaluable help and advice which was appreciated.

INTRODUCTION

In April 1975, Kaiser Steel Corporation entered into a cost-sharing contract with the Government for a shield-type roof support demonstration on the longwall faces at York Canyon Mine, New Mexico.

Terms of Contract

In this cost sharing contract, the Government provided the longwall shields and hydraulic pumps. Kaiser provided the shearing machine, face conveyor, stage loader, auxiliary equipment and labor force for the three panel demonstration. Upon project completion, the Government was to retain the shields and Kaiser would retain the remainder of the face equipment. In return for the coal produced during the project, Kaiser was responsible for reporting to the Government on all aspects of longwall mining during the course of the project. This report provides all the information for the demonstration at the York Canyon Mine.

Objectives of Contract

Recognizing the inherent increased productivity, health and safety, and resource recovery of longwall systems, the Government set out to educate the U. S. coal industry on this mining method. The purpose of this longwall demonstration was to provide data for the U. S. coal industry on all aspects of longwall mining with specific emphasis on shield type supports. In addition, the project provided a working model for industry to observe and compare with other mining methods.

Contents of Report

This report examines shield and face operations throughout the course of the demonstration at York Canyon. Mining conditions and problems encountered during the project are also examined. An evaluation of shield and face performance is presented. This evaluation includes safety, production, costs, maintenance, ventilation, roof control, illumination, and performance in adverse conditions. Finally, a comparison of the shield demonstration face with a chock face and another shield face at York Canyon is made where possible. Comparisons will also be made with national averages and published literature on longwalls in the United States.

COMPARISON OF CHOCKS AND SHIELDS

Longwall mining has been practiced in Europe for many years as a method for attaining high prod ion and high recovery. Since the introduction of powered self-advancing roof supports in the early 1950's, the acceptance and utilization of longwall methods has increased significantly. The development of chock and frame type supports revolutionized the coal mining industry and resulted in increased productivity, recovery, and safety. Shield supports were developed in the Soviet Union and introduced to West Germany in 1970. The development of this type support has been largely responsible for the recent surge of longwall mining in the United States today (Merritt and Davis, 1977, p. 81).

The type of roof support chosen for the longwall face is a very important decision. Because of the high capital expenditure required for the purchase of a longwall face, it is necessary to choose the support system best suited to the unique financial and mining conditions of an operation. Both chocks and shields have common elements of hydraulic cylinder legs attached to a base and to some type of roof supporting canopy. Their function is to support the roof, move the face conveyor by a ram arm operating from the base, and to move themselves forward (Merritt and Davis, 1977, p. 80).

Chock Supports

The major consideration for purchasing a chock face is cost. Chocks are 20-30% lower in cost than shields. This is very important for ventures operating with tight capital or marginal operations. If conditions are favorable to a chock face, it can operate just as effectively as a shield face could. In addition to this, chocks are particularly suited to conditions with a strong and blocky breaking roof such as a massive sandstone. In areas which require high support density, chocks allow for the total amount of hydraulic force available to be applied to the roof. Chocks may also be applicable in low seams where gob flushing characteristics are not a problem. Chocks, being much lighter than shields, are much easier to transport, expediting panel moves after a panel has been completed.

Because of their design, chocks may become unstable in higher seams. Since all legs are vertical, chocks offer little resistance to lateral forces. These type forces may cause chock deformation or toppling in higher seams. Considerable problems may also be encountered in areas where the roof is very friable and has a tendency to break into small pieces (Euler, 1978, p. 74). Finally, since chocks are generally open to the rear, gob flushing may become a problem.

Shield Supports

Shield supports offer a solution to most problems encountered with chock type supports. Their design results in a stable support which creates a forward thrust during yielding that maintains the integrity and strength of the roof strata (Euler, 1978, p. 72). Because the shields have a skin to skin arrangement and protect from gob flushing, they result in a safer working environment. This design also allows for mining in areas with fragile or friable roof conditions. Because of their stability, shields can be utilized in a wide variety of seam heights. Ventilation of shield faces is also more efficient because the face is completely enclosed, allowing for lower air losses to the gob and less resistance.

Problems associated with shield faces are few. In areas with soft or incompetent floor rock, shields have a tendency to sink into the floor due to their extreme weight and the way forces are applied to them (Euler, 1978, p. 73). Shields are also harder to move from face to face because they are heavier and more bulky.

The contract with the Government offered an excellent opportunity for Kaiser to evaluate the performance of shield type supports at York Canyon without having to consider the cost of buying a new face. Aside from this, the contract offered the opportunity to recover high coal at the north end of the mine. Previously, this coal could not be recovered by longwall methods due to operational constraints of the Dowty chocks already in use at York Canyon. The coal at the north end of the mine varied from 2.4 to 3.7m (8-12 ft.) high. Recovery of this high coal was previously accomplished by room and pillar techniques because the maximum operating height of the existing chock face was only 2.1m (7 ft.). The Government shields would allow for recovery of coal between 1.7m (5.5 ft.) and 3.4m (11 ft.) high. In addition to this, the chock face experienced difficulty negotiating fault zones which are common at York Canyon. This resulted in designing shorter panels between known faults and mining in the faulted areas with continuous miners. Since the shield legs could act independently of each other, negotiating faults would be much easier. The skin to skin arrangement of the shields would result in easier and safer mining of faulted and poor roof areas. After considering all aspects of the contract and the advantages of the shield face, Kaiser concluded that the contract with the Government would allow for a safer, easier, more productive, and more economical recovery of the coal at the north end of the mine.

The Government shield demonstration longwall started production in May, 1975. At that time, it was the second shield longwall panel in the United States. The first shield longwall panel started production at Consolidated Coal Company's Shoemaker Mine in April, 1975. By this time, 75 shield longwall panels were producing coal in West Germany (Linden, 1977, p. 156).

MINE SETTING AND HISTORY

Location

The location of the York Canyon Mine is shown on figure 1. The mine is located in sec. 4, T. 31N., R 19E., approximately 16.1 km (10 miles) south of the New Mexico-Colorado border and 64.4 km (40 miles) west of Raton, New Mexico. The location of the three demonstration panels within the York Canyon Mine is also shown in figure 1. Panel centerlines are oriented northwest-southeast and the direction of the mining advance was towards the southeast.

Land Use

The York Canyon Mine is located in an area with a semi-arid to sub-humid climate (Yi-Fu and others, 1969, p. 159). The area is characterized by approximately 50.8 cm (20 inches) of annual precipitation (Yi-Fu and others, 1969, p. 18). Temperature variations range from an average daily maximum of 24° C (65°F) to an average daily minimum of -1° C (31° F) (Von Eschen, 1961, p. 47). Summer high temperatures generally reach the low 32°C (90 F°) range while winter low temperatures generally average in the low -7°C (20°F) range.

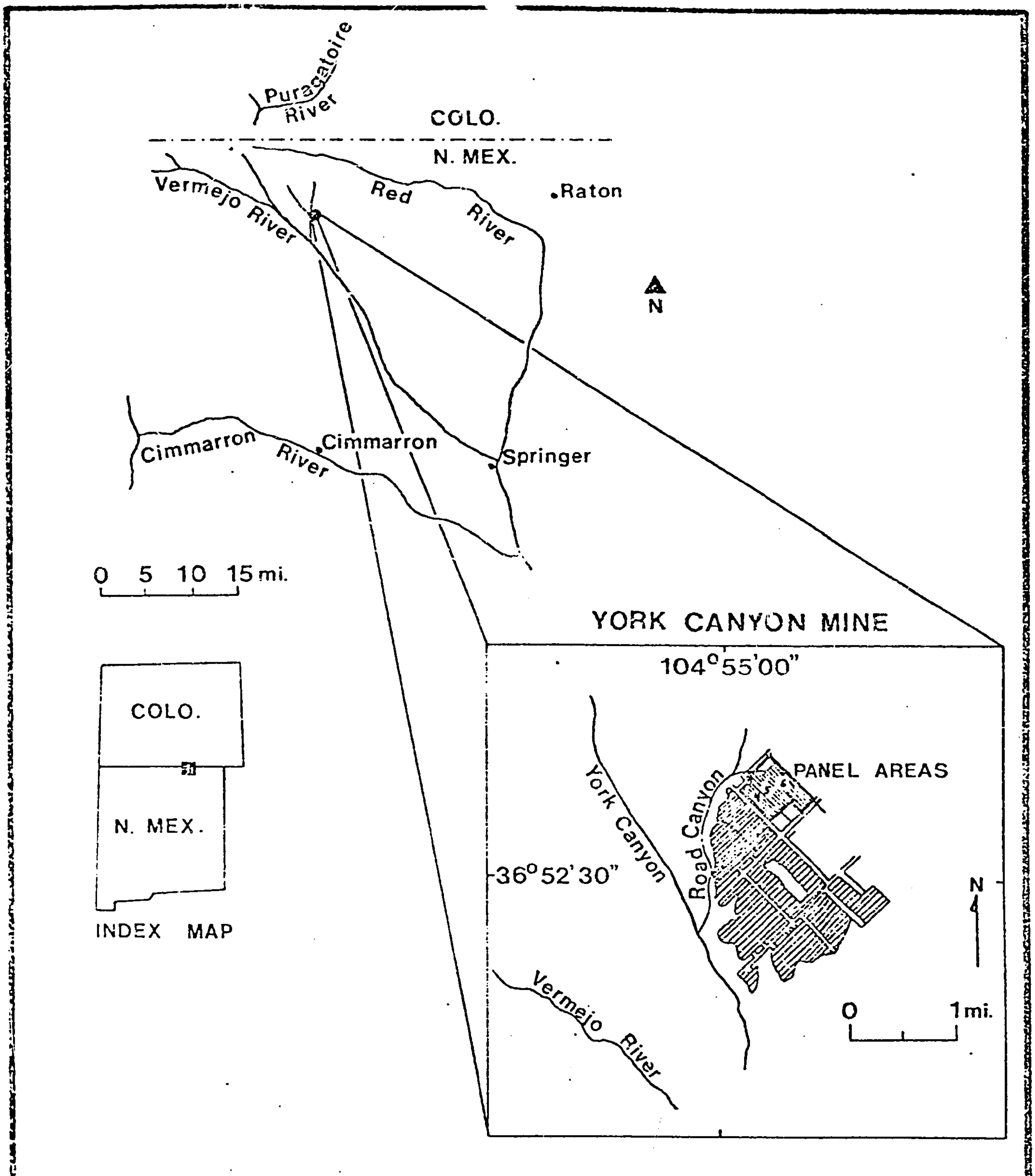
Vegetation in the area consists principally of trees, low shrubs, and grasses. The area is moderately forested with primarily evergreens. The regional area is utilized primarily for cattle ranching with some timber cutting operations and localized mining activity. While the area is dotted with numerous abandoned coal mines, York Canyon is the only active operation in the region. The area also provides sport hunting and fishing.

Both York Canyon and Road Canyon contain intermittent streams which are dry most of the year. The water supply for the mine comes from the nearby Vermejo River and from underground wells. Photograph 1 shows the surface over the demonstration site.

Topography

The regional topography is irregular, developed and variably resistant, slope forming beds of sandstone, siltstone, shale, and coal (figure 2). There are three principle landform types· flood plains, valley slopes, and ridge crests. York Canyon and Road Canyon are the principle drainages and have provided the controlling factors in the development of topographic landforms in the demonstration area. Photograph 2 shows the topography of the area.

The topography over the demonstration area is very diverse (figure 3). Panel 4 - North topography consists of a dissected terraced slope that connects the flood plains of Road and York Canyons with the adjacent



LOCATION MAP

FIGURE 1

AGE		FORMATION	LITHOLOGY
TERTIARY	PALEOCENE	POISON CANYON FORMATION	Medium - to very course-grained sandstone with interbedded shale.
TERTIARY / CRETACEOUS	PALEOCENE / UPPER CRETACEOUS	RATON FORMATION	Fine- to course-grained arkosic sandstone with interbedded gray shale and coal beds.
CRETACEOUS	UPPER CRETACEOUS	VERMEJO FORMATION	Interbedded gray shale, carbonaceous shale, coal beds and gray arkosic sandstone (NON-MARINE).
CRETACEOUS	UPPER CRETACEOUS	TRINIDAD SANDSTONE	Buff to gray, fine- to medium-grained arkosic sandstone (TRANSITIONAL).
CRETACEOUS	UPPER CRETACEOUS	PIERRE SHALE	Dark gray, non-calcareous shale (MARINE).

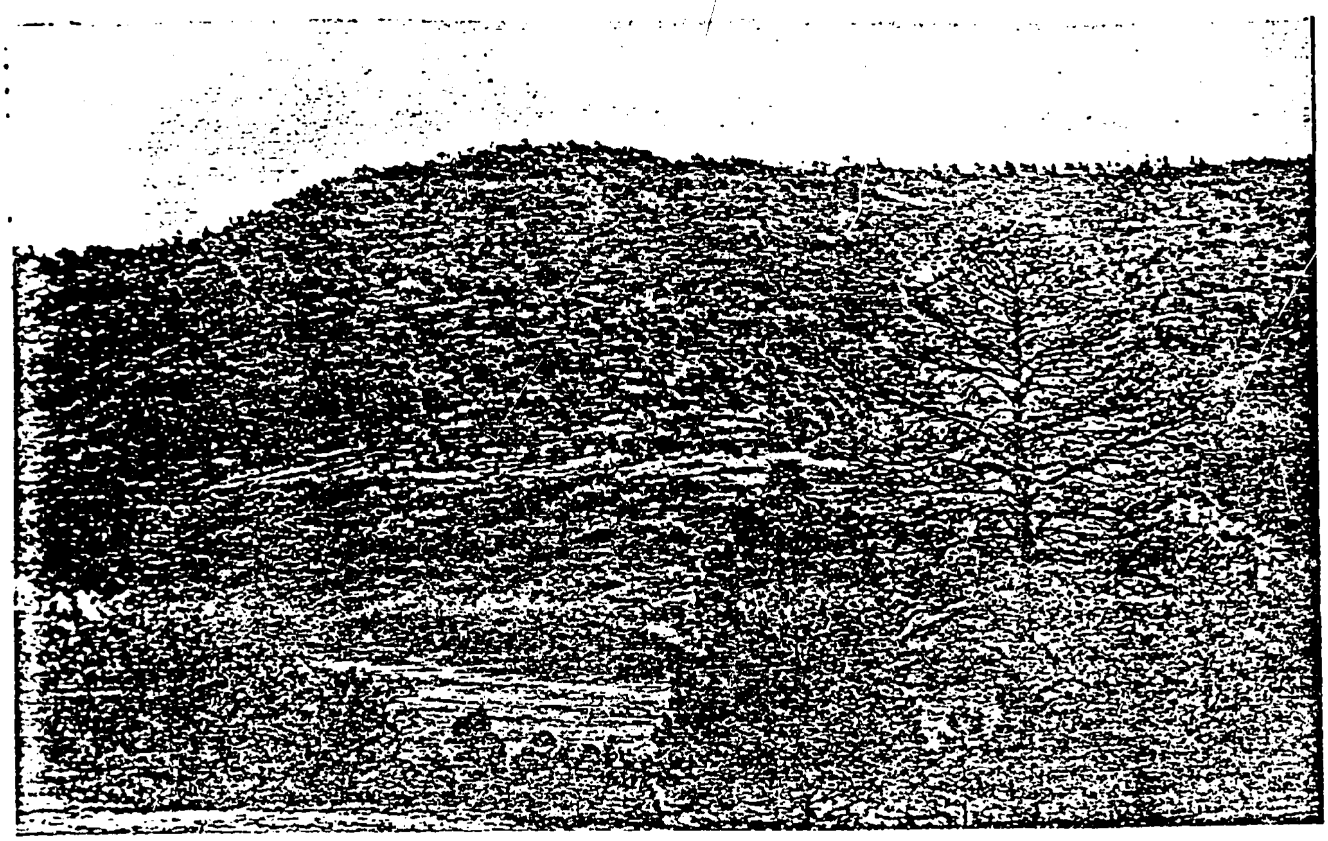
NOTES:

1. Modified from Pillmore, 1969, p. 129, Table 1 and Clark, 1966, p. 60 - 61.

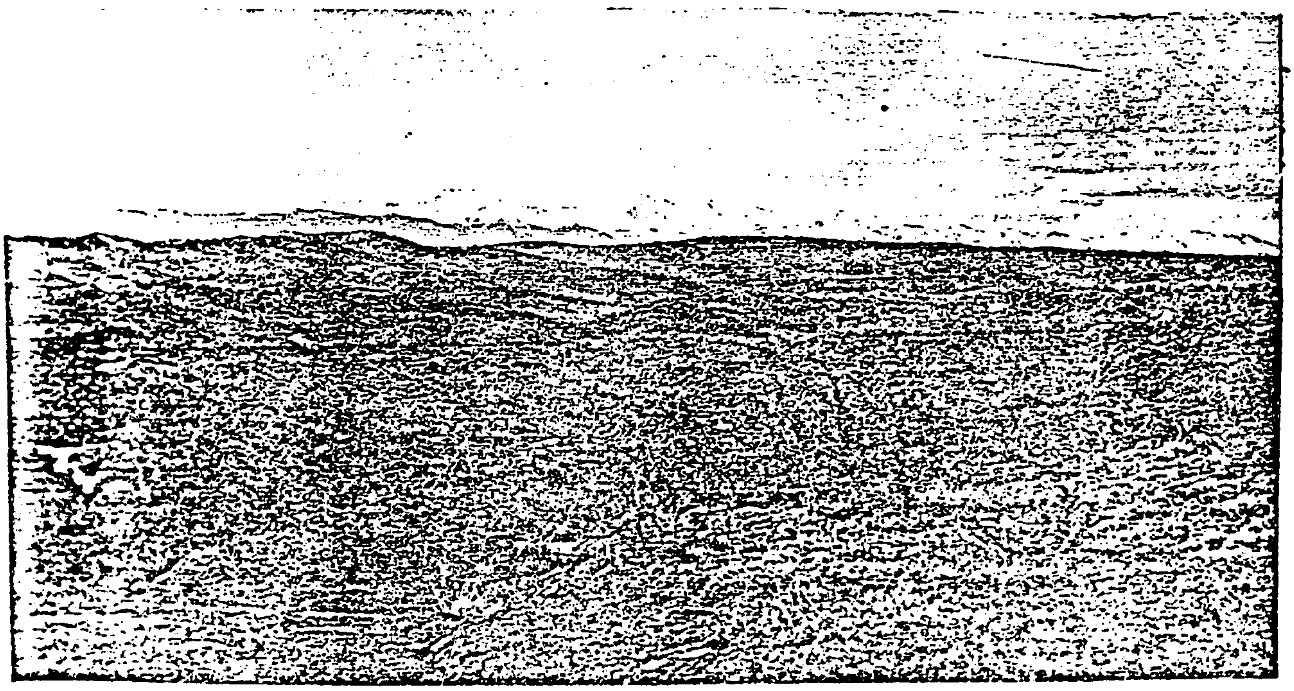
2. A Regional Geologic Map is presented on Figure 4.

REGIONAL STRATIGRAPHY

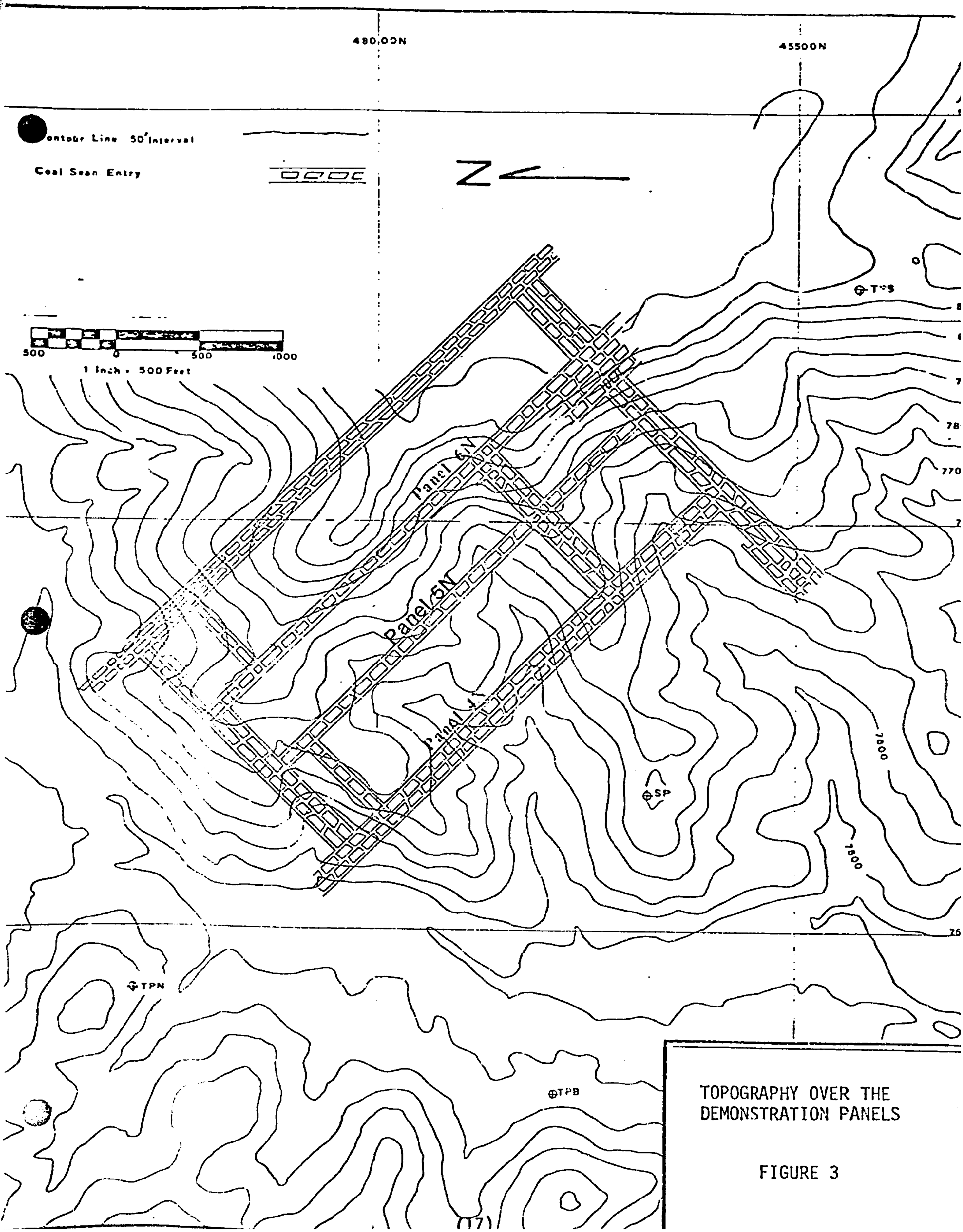
FIGURE 2



Photograph 1; Surface above demonstation site



Photograph 2; General topography of the area



TOPOGRAPHY OVER THE DEMONSTRATION PANELS

FIGURE 3

terraces slopes. Slopes over the area average between 8 and 25 degrees. This represents much steeper slope segments which connect the terraced benches. Elevations in the demonstration area range from 2332m (7650 ft) over panel 4-North to 2499 m (8200 ft) over panel 6-North.

General Geology

The York Canyon Mine is located in the southern part of the Raton Basin (figure 4). This basin is a large arcuate structural and depositional trough that extends roughly from Huerfano Park, Colorado to Cimarron, New Mexico (Pillmore, 1969, p. 125). The basin is bounded on the west by the foothills of the Sangre de Cristo Mountains and on the east by the Sierra Grande Arch (Johnson and others, 1966, p. 88).

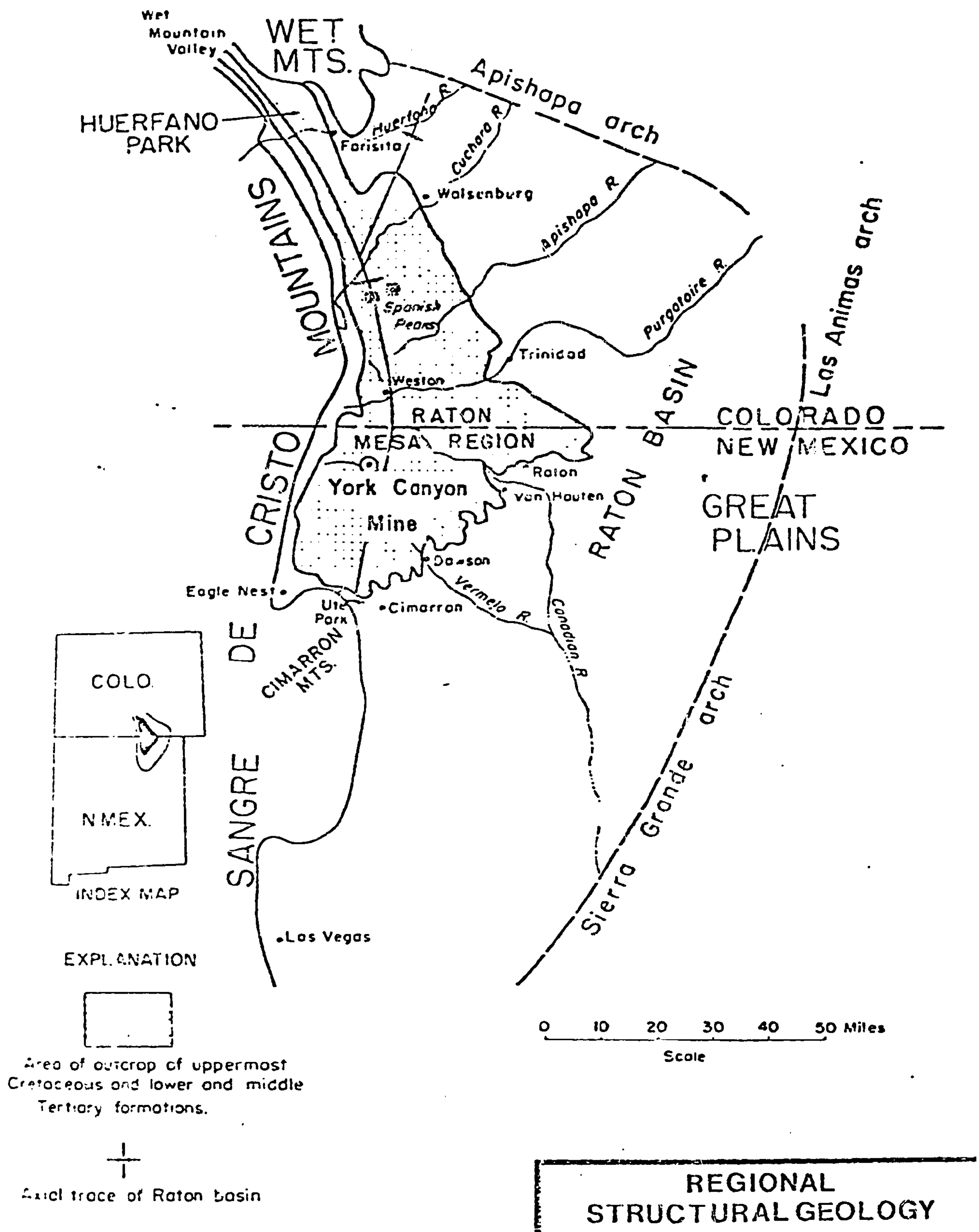
The development of the Raton Basin began during Late Cretaceous times when the North American plate drifted over the eastward dipping subduction zone (Woodward and Snyder, 1976, p. 126). As the Sangre de Cristo uplift began to rise, the adjacent Raton Basin began to sink and thick continental sediments were deposited (Woodward and Snyder, 1976, p. 126). The stratigraphic sequence consists of alternating shales, sandstone, and siltstones with lenses of coal. This stratigraphic section represents the final regression of the Cretaceous sea and the subsequent deposition of sand, silt, mud, and carbonaceous material on low lying flood plains, in coastal swamps and on deltas (Johnson and others, 1966, p. 94). Tertiary dikes and sills have intruded the region but are not present in the area of the mine.

The York Canyon Mine produces coal from the York Canyon seam in the coal bearing zone of the Raton Formation (Pillmore, 1969, p. 134-135). The coal bed is a lenticular shaped deposit of lower Paleocene to upper Cretaceous age.

Mine History

In 1955, Kaiser Steel Corporation acquired 530,000 acres of coal rights in northeastern New Mexico from the St. Louis, Rocky Mountain and Pacific Company. Prior to this transaction, the St. Louis, Rocky Mountain and Pacific Company had operated the Koehler Mine on a limited basis. Kaiser expanded the operation of the Koehler Mine and began an extensive drilling and exploration program. This program proved successful and several substantial deposits of coal were outlined. The most attractive of these deposits was located at the fork of York Canyon and Road Canyon. A test mine for exploration purposes was opened at this location early in 1964. The quality of the coal proved ideal for Kaiser's use and access was excellent. Construction of the York Canyon Mine facilities began in 1965. In 1966, the York Canyon Mine went into full production and the Koehler Mine was closed.

The York Canyon Mine is a drift mine developed from two portal areas at the outcrop. These portal areas are the Main Portal on the south side of the mine and the Prospect Portal on the north side of the mine. The mine was developed using a four-entry main system from each



NOTES:

1. Map modified from Johnson and others, 1966, p. 89, Fig. 1.

2. Regional stratigraphic section is presented on Fig. 2

REGIONAL STRUCTURAL GEOLOGY

FIGURE 4

portal area. These mains extend 2804m (9200 ft.) in from the main portal and 1554m (5100 ft.) in from the prospect portal. Both sets of mains are developed in a N45°W direction. On either side of the entries driven in from the Main Portal, section entries are driven. As one enters the Prospect Portal, sections are developed only on the left hand side. These sections are labeled 1-North, 2-North, 3-North, 4-North, 5-North, and 6 North. It is in this area of the mine that the shield demonstration was located.

The mine was developed using Joy 6-CM ripper type miners. These miners have been replaced by Lee-Norse HH-386 continuous miners. In January, 1973, the Dowty Meco chock longwall face began production. Since that time, the chock face mined five longwall panels and was replaced by Hemscheidt G-320 shields in 1977. Early in 1975, Kaiser started its second longwall using Hemscheidt 320 HSL shield supports. This longwall was the one provided by the U. S. Bureau of Mines for the longwall shield demonstration project.

Prior to the demonstration, the chock longwall panels had difficulty negotiating fault zones. Roof control in these areas was a problem. Subsequently, the chock panels were planned and laid out to avoid known fault zones. These fault zones were mined by continuous miner room and pillar sections. Smaller unknown faults were negotiated by the chock longwalls. Planning longwalls around known faults made panels as small as 304.8m (1000 ft) long. After the demonstration, future longwall panels are planned at as much as 2195m (7200 ft.) long.

During 1978, the York Canyon Mine operated four continuous miner sections and two longwall sections. The mine produces approximately 910,000 metric tons (1,000,000 short tons) of coal per year. Underground coal haulage is accomplished with a conveyor system which exits the mine through the Main Portal. Supply haulage is by battery scoop trams. Mine ventilation is obtained with three axial-vane blowing fans exhausting to five ventilation raises on the outskirts of the mine. Two of these fans are located at the Main Portal and produce a combined volume of about 106 cubic meters/sec. (225,000 CFM). The third fan is located at the Prospect Portal and supplies about 52 cubic meters/sec. (110,000 CFM) to the north side of the mine. Roof control throughout the mine is maintained by use of mats in addition to 1.8m (6 ft.) resin and conventional roof bolts. Additional timber, cribs, and H-beams are used in areas with poor roof conditions.

Coal is shipped by train from York Canyon to Kaiser Steel's mill in Fontana, California after being washed. A coal analysis yields the following information on clean coal:

8%	Ash
0.5%	Sulphur
14,000	BTU/lb
1.4	Specific Gravity

SHIELD DESCRIPTION

The longwall supports used in this demonstration were Hemscheidt 320 HSL, 2 leg, 317 metric ton (350 short ton) capacity, caliper type shields. These shields were made and supplied by Hemscheidt America Corporation. The shields were recommended for medium to high seam conditions. They have a collapsed height of 1.5 m (59 in.) and an open height of 3.5 m (138 in.). The actual operating height ranges from 1.7 m to 3.4 m (67 in. to 132 in.). Each shield weighs 9.1 metric tons (10 short tons). The shields are designed to be placed on 1.5 m (59 in.) centers when installed. Tables I and II show the shield design characteristics for various mining heights and hinge pin positions.

The shields are constructed of four basic structural components. These components are the hydraulic legs, shield base, roof canopy, and gob shield. In addition to these structural components, the shields are equipped with face shields, side shields, a DA ram arrangement, and the hydraulic controls. Figure 5 is a sketch showing the parts of the shield. Figure 6 is a ..ontal view of the shields.

Hydraulic Legs

The Hemscheidt shields used in this demonstration utilized two hydraulic legs per shield. Each of these legs is rated at 160 metric tons (176 short tons) with a yield pressure of 6000 psi. At a setting pressure of 4500 psi, the legs are rated at 120 metric tons (132 short tons) each. Each leg is double acting without internal check valves. Figure 8 is a sketch showing the parts of the shield leg.

Without leg extensions, the legs have a closed length of 1.2 m (46.7 in.) and maximum hydraulic travel 71 cm (28.1 in.) resulting in a total length of 1.9 m (74.8 in.). With the mechanical leg extensions, an extra 66.5 cm (26.2 in.) can be added for a fully extended length of 2.6 m (101 in.). The mechanical extensions are always inside the leg whether they are used or not. A mechanical hinged collar fits over the extension and outer leg cylinder. To raise or lower the extension, the collar is unbolted, the extensions are raised or lowered, and the collar is bolted back into position. This process is very simple and takes between 5 and 10 minutes. Problems may arise if the extensions are out too far for the seam height. If the roof begins to squeeze under these conditions, there may be no hydraulic travel left in the legs and the legs may become ironbound. This could result in bent legs.

The shield legs are attached to the gob shield and to the base by pins. If a leg needs to be replaced, the pins are removed, a new leg is set into position, and the pins are replaced. The legs can be set for either high or low coal by changing the pin position on the base of the shield. For mining heights between 2.4 m and 3.4 m (8 ft. and 11 ft.), the front pin position is used. For mining heights between 1.8 m and 2.7 m (5.8 ft. and 9 ft.), the rear pin position is used. To change

TABLE I
DESIGN CHARATERISTICS FOR VARIOUS
MINING HEIGHTS AND HINGE POSITIONS
(SETTING PRESSURE 5000 PSI)

HINGE POSITION UP = U DOWN = D	SUPPORT HEIGHT H * FEET	SHIELD LEG FORCE S * TONS	LEVER RATIO e/f *	FORCE AT HINGE P * TONS	C x 5'* ROOF SURFACE CONTACT AREA SQ. FT.	SUPPORT RESISTANCE P/5C * TONS/SQ. FT.	RESISTANCE/HEIGHT TONS/CUBIC FT.	ANGLE γ * DEGREES	DISTANCE TO COAL K * INCHES
D	5.02	293	0.4	117	46.3	2.53	.503	-9°	11.8
D	6.56	293	0.482	141	48.4	2.91	.444	-2°	7.9
D	8.20	293	0.5964	165	47.1	3.50	.427	+5°	7.9
U	8.20	293	0.593	174	40.4	4.31	.525	-7°	7.9
U	9.84	293	0.65	190	44.1	4.33	.440	0°	7.9
U	10.50	293	0.68	200	46.8	4.27	.407	+3°	7.9
U	11.81	293	0.783	229	53.3	4.30	.364	+10°	22.4

* SYMBOLS REFER TO FIGURE 5

TABLE II
DESIGN CHARATERISTICS FOR VARIOUS
MINING HEIGHTS AND HINGE POSITIONS
(YIELD PRESSURE 6000 PSI)

HINGE POSITION UP = U DOWN = D	SUPPORT HEIGHT H * FEET	SHIELD LEG FORCE S * TONS	LEVER RATIO e/f *	FORCE AT HINGE P * TONS	C x 5'* ROOF SURFACE CONTACT AREA SQ. FT.	SUPPORT RESISTANCE P/5C * TONS/SQ. FT.	RESISTANCE/HEIGHT TONS/CUBIC FT.	ANGLE γ * DEGREES	DISTANCE TO COAL K * INCHES
D	5.02	352	0.4	141	59.2	2.38	.474	-9	43.3
D	6.56	352	0.482	169	61.3	2.76	.420	-2	39.4
D	8.20	352	0.564	198	60.2	3.29	.401	+5	39.4
U	8.20	352	0.593	209	53.3	3.92	.478	-7	39.4
U	9.84	352	0.65	228	57.0	4.00	.407	0	39.4
U	10.50	352	0.68	239	59.7	4.00	.381	+3	39.4
U	11.82	352	0.783	275	66.2	4.15	.352	+10	53.9

* SYMBOLS REFER TO FIGURE 5

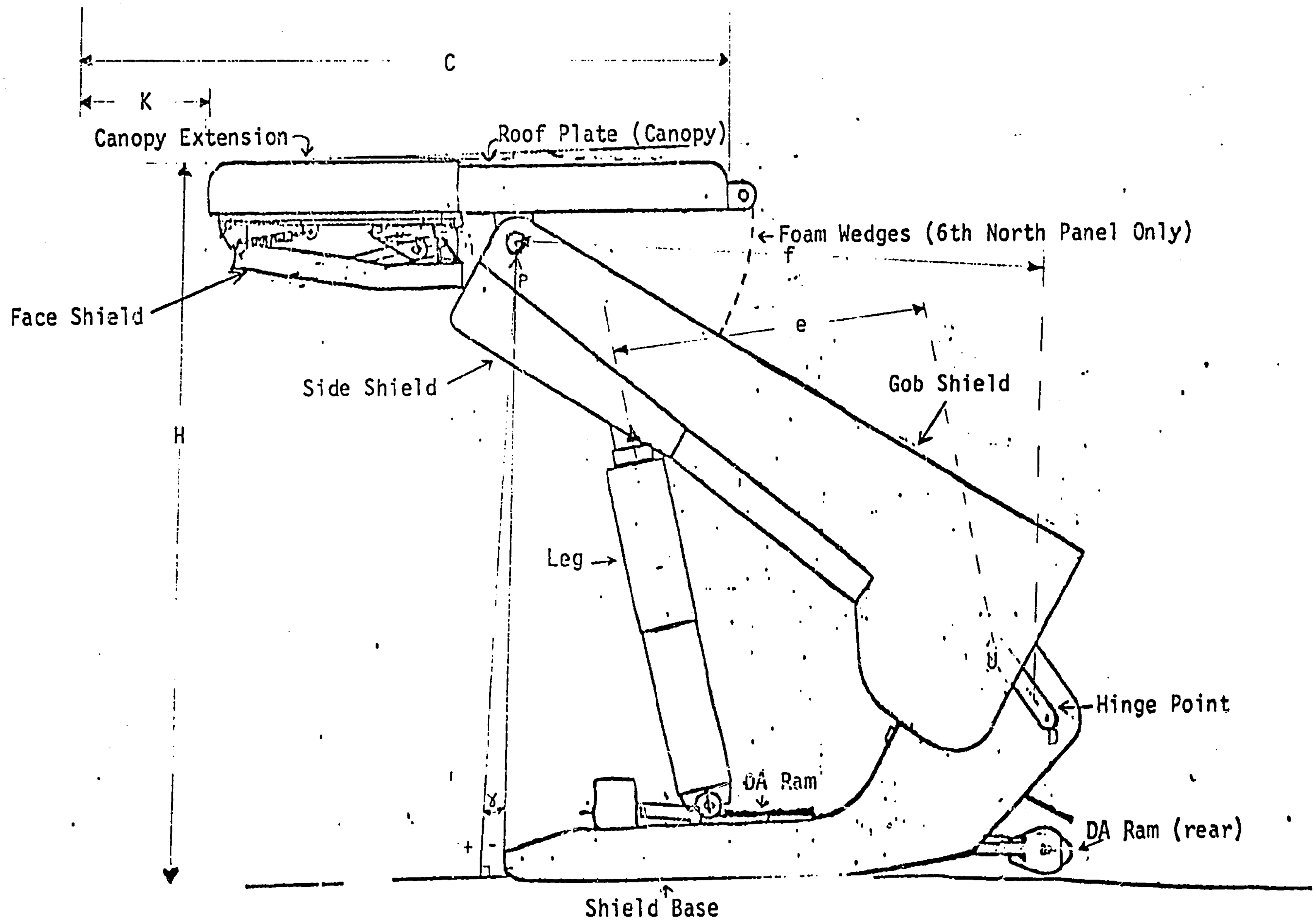


FIGURE 5; Hemscheidt 320HSL Shield parts (side view) and design characteristics chart symbols.

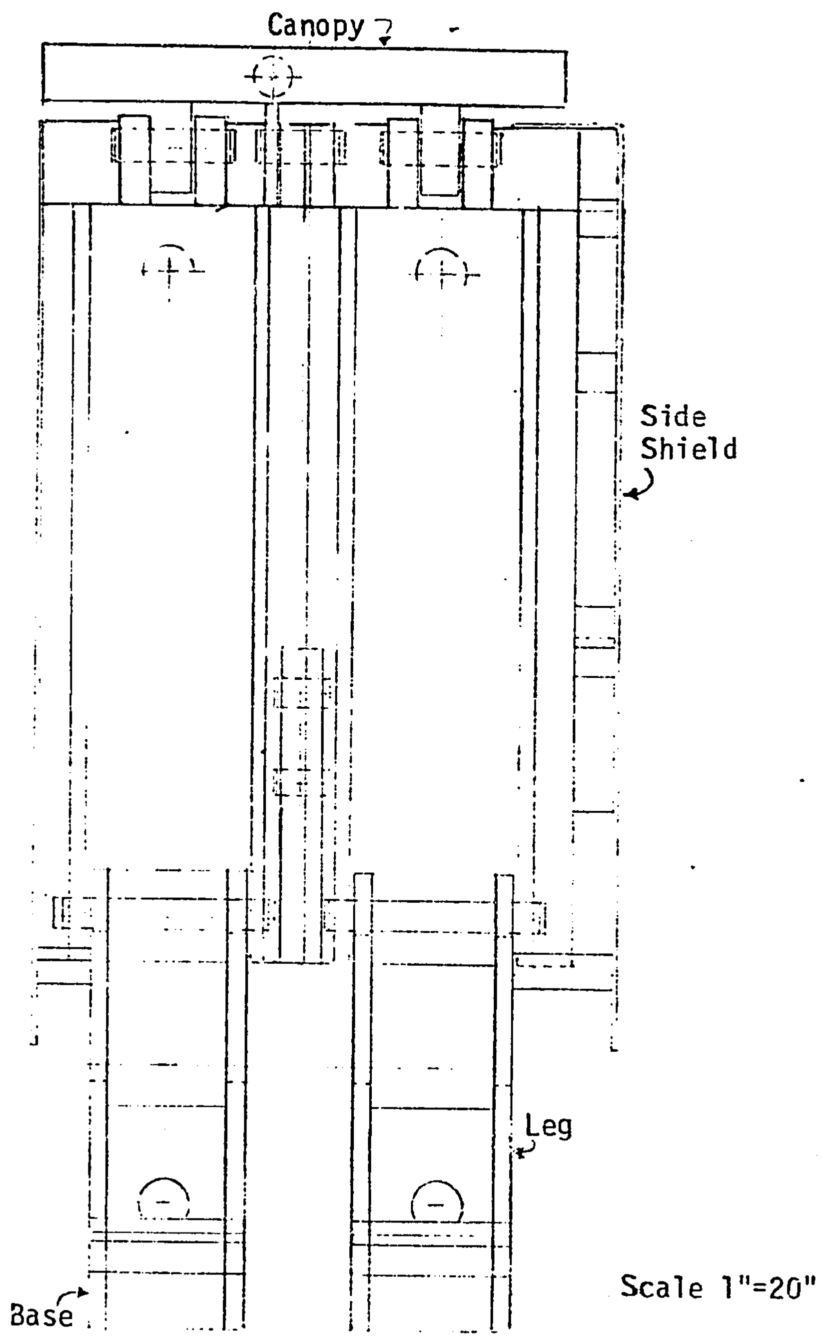


FIGURE 6; Hemscheidt 320HSL Shields (Frontal view).

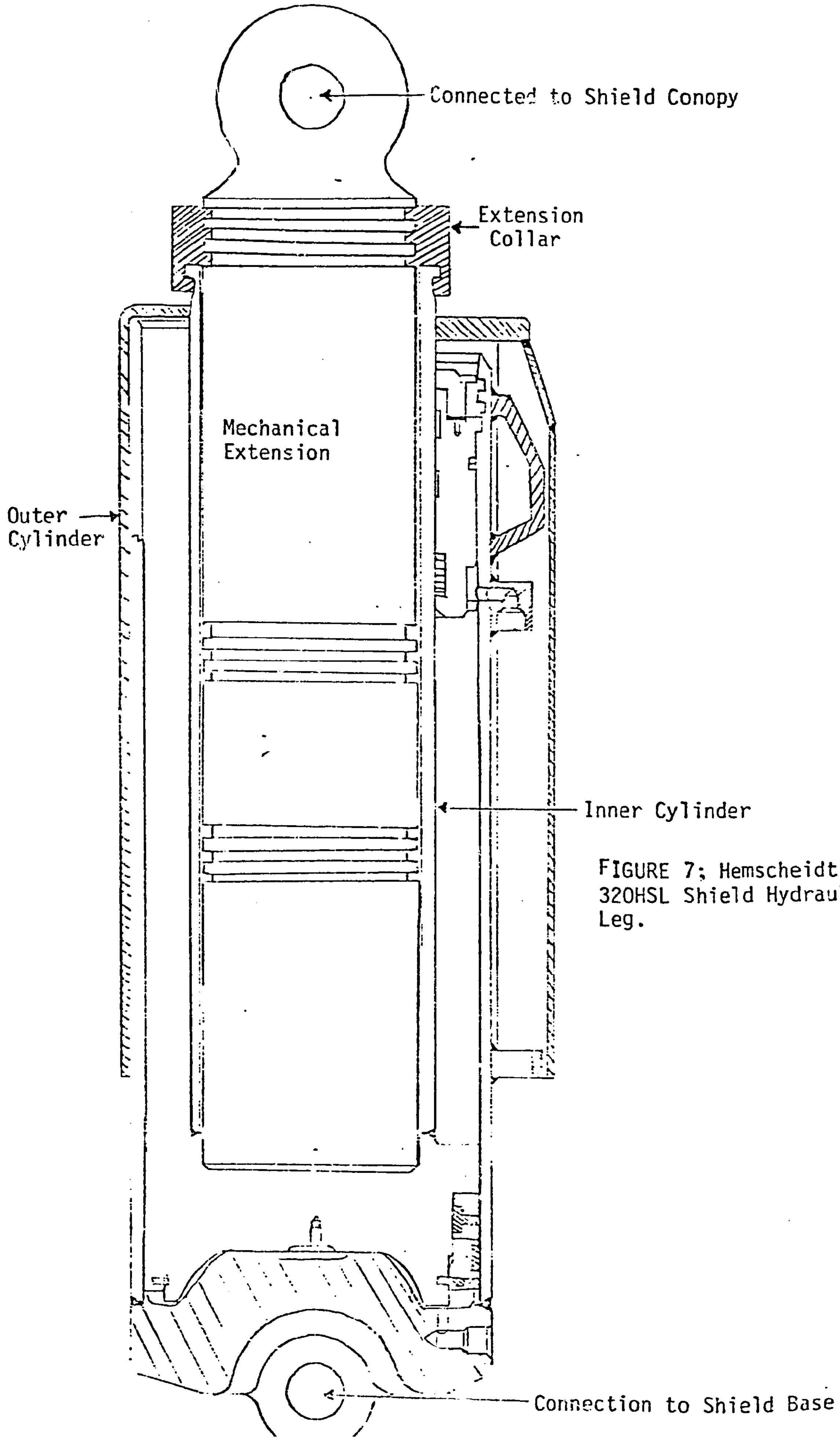


FIGURE 7; Hemscheidt 320HSL Shield Hydraulic Leg.

the leg position, the pin connecting the leg to the base is knocked out and the leg is slid backwards or forwards to the desired position. The pin is then replaced. The angle of the leg from vertical varies from 4 to 40 degrees for mining heights between 3.35 m and 1.7 m (138 in. and 67 in.).

The outer leg has an inside diameter of 28 cm (11.0 in.) and a wall thickness of 1.70 cm (0.699 in.). The inner leg has an outside diameter of 26 cm (10.24 in.) and a wall thickness of 1.70 cm (0.669 in.). The mechanical extensions have an outside diameter of 22 cm (8.66 in.) and an inside diameter of 16.8 cm (6.6 in.). The outer leg can overlap the inner leg up to 26.9 cm (10.6 in.) and the inner leg can overlap the mechanical extensions up to 48.3 cm (19in.). The mechanical extensions, inner leg, outer leg, and leg holder are all constructed of 64,000 psi yield strength steel with a 0.3 micron surface finish smoothness. These are all plated with 40-50 microns of copper.

On each leg there is a pop out pressure gauge consisting of a cylinder with grooved rings. The higher the pressure, the further the cylinder is pushed out and the more the rings are visible. If the yield valves are not working, these gauges indicate if the legs are taking excess pressure.

Shield Base

The shield base is constructed using a twin beam arrangement. This method of construction allows each beam and attached leg to act independently. This arrangement is very useful in areas of soft bottom or in fault zones. When problems like these are encountered, each leg can be lifted independently and cribbing or blocks can be placed under the base. With a single beam construction, there is no way of cribbing or blocking under the shield base without retracting both legs and jacking the entire base up. The twin beam construction is also useful for remedying conveyor hangups. In this case, blocks can be placed between the conveyor pan and the shield base. One leg is then raised, lifting the face conveyor and helping to free the conveyor flights.

Each of the two beams is 40.1 cm (15.8 in.) wide and 25.4 cm (10 in.) high. The two beams are 30 cm (11.8 in.) apart and 49.9 cm (15.7 in.) from the nearest beam on the adjacent shield. The base covers a total ground area of1.52 sq. m (16.35 sq. ft.) and exerts a maximum average ground pressure of 308 psi. This is a total ground force of about 328 metric tons (362 short tons) per shield. The shield base is constructed with 51,000 psi yield strength steel. Welded box girder type construction is used to manufacture the base with 3.05 cm (1.2 in.) and 4.06 cm (1.6 in.) plates and 4.0 cm (1.575 in.) thick webs. The bases are constructed to be self-cleaning so they do not accumulate mud. Anti-skid plates were welded to the legs of the bases for each shield because they presented a safety hazard. The front of the base slopes downward and resulted in many miners slipping and falling. The anti-skid plates helped, but the slanting base still presents a hazard if conditions are wet or if the base is covered by loose coal or rock.

The shield base supports both the hydraulic legs and the gob shield. Both the hydraulic legs and gob shield are connected to the base at hinge points with pins. The pin positions can be adjusted to accomodate either very high or lower seam heights.

Gob Shield

The gob shield provides full protection from the gob and supports the roof canopy. The gob shield is constructed from 51,000 psi yield strength steel. It has a welded box girder construction with 1.27 cm (0.50 in) plates and webs between 2.0 cm (0.787 in) and 4 cm (1.575 in) thick.

The main hinge point for the shield connects the gob shield and the shield base. This hinge point has a vertical adjustment which can be set for high or low seam heights. For seams greater than 2.54 m(100 in), the hinge should be set in the lower position. Changing the hinge point is difficult and should be done during panel moves. To change the hinge position, the entire weight of the shield must be taken off the hinge and supported. The pivot pin has a diameter of 7 cm (2.75 in) and a yield strength of 155,000 psi.

Roof Canopy

The Hemscheidt 320 HSL shields utilize roof canopies with canopy extensions. These canopies are 135 cm (53.15 in) wide and have a roof contact area of 3.5 sq. m (37.7 sq. ft) with the extensions retracted and 4.2 sq. m (45.2 sq.ft) with the canopies extended. The canopy extension is hydraulically actuated and has 50.8 cm (20 in) of travel. The canopy is 259 cm (102 in) long in the retracted position and 310cm (122 in) long when the canopy is extended. Using the correct leg and hinge positions, the canopy can be kept within 8 in of the face.

The shield canopies are constructed of 51000 psi yield strength steel. Welded box girder type construction was used to manufacture the canopies utilizing 2.0 cm (0.78 in) to 4 cm (1.575 in) thick plates. The load capacity at a yield pressure of 6000 psi and a 0.3 friction factor for the legs is 397 metric tons (438 short tons) at the maximum operating height and 190 metric tons (210 short tons) at the minimum operating height. The maximum contact pressure is 94,633 Kg/m^2 (9.69 tons/ sq ft) at the maximum operating height. The canopies are supported by pins connecting them to the gob shields.

The roof canopy employs hydraulic tip control by means of two tip control cylinders. These cylinders are built into the roof canopy and provide a tip load of 5.0 metric tons (5.5 short tons) when moving the shields. The bore diameter of these cylinders is 8.77 cm (3.453 in) and the rod diameter is 5.08 cm (2.00 in). The cylinders have 18 cm (7.087 in) of travel length and operate between 4473 psi and 5000 psi.

The shields are designed so that a constant roof pressure can be maintained when moving the shield. This is useful in areas having poor roof conditions. A constant upward pressure of up to 9.1 metric tons (10 short tons) can be obtained by installing a special valve in the return of each shield. This constant soft pressure is automatically applied when moving the shield unless a hand operated bypass valve is used.

Each canopy is equipped with four water spray nozzles. Two of these nozzles are positioned to spray towards the gob. The other two nozzles are positioned 25.4 cm (10 in.) in front of the hinge point where the canopy connects to the gob shield. These nozzles spray towards the adjacent shields. The sprays automatically engage whenever the shields are lowered. All piping and nozzles are welded into the roof canopy. At York Canyon, the water sprays were disconnected because the excess water made the floor soft. In addition, maintaining the system was very difficult because the piping and nozzles became plugged very easily.

Face Shields

In addition to canopy extensions, the shields came equipped with face shields. The face shields were attached to the front of the canopy extension with a pin arrangement. The purpose of these face shields is to protect the workers from falling coal from the face in high mining conditions. The face shields rarely, if ever, made contact with the coal face. The face shields exert a maximum 6.35 metric tons (7 short tons) to the face over a 0.46 sq. m (5 sq. ft.) area. The face shields were removed on panel 6-North to accommodate the lower expected mining height.

Side Shields

The side shields consist of hree hydraulic cylinders and two springs connected to a 1.27 cm (0.50 in.) thick steel plate. The side shields keep the space between the shields closed so that no loose rock can fall through. The side shield extensions were removed from panel 6-North to provide greater access under the shields in the lower expected mining height.

DA Ram Arrangement

Each shield is equipped with a hydraulic DA ram which provides the force to move the shields and face conveyor. These rams are located along the center of the shield base between the two beams. The rams are double acting and have an operating pressure of 4500 psi to 5000 psi. At 4500 psi, the ram can supply a force of 15.1 metric tons (16.7 short tons) to push the face conveyor forward and 27.5 metric tons (30.3 short tons) to pull the shield forward. The DA rams have a piston area of 86 sq. cm (13.33 sq. in.) on the bore side and 48 sq. cm (7.44 sq. in) on the rod side. The ram has a total stroke of 85.1 cm (33.5 in.) and a rod diameter of 7 cm (2.75 in.). The ram rod extends to the rear of the shield where it connects to a bridle. Reach rods extend from this bridle forward on both sides of the ram and connect to the face conveyor through a second bridle arrangement. These reach rods transmit the force from the DA rams to the face conveyor.

Hydraulic Controls

The hydraulic control block contains the valves for operating the shields. With these controls, the legs, canopy, face shield, side shield, and DA Ram can be operated. On panels 4-North and 5-North, the controls were mounted onboard the shields. In this position, the operator stands under the shield he is moving. Since the expected mining height for panel 6-North was much lower, the controls were switched to adjacent control. In this position, the operator stands under the shield next to the one he is moving. With adjacent control, the operator has more room and is better protected from rocks falling between the shield canopies.

DESCRIPTION OF DEMONSTRATION SITE AND EQUIPMENT

The demonstration site consisted of three adjacent longwall panels developed at the North end of the mine. These panels were named 4-North, 5-North, and 6-North (figure 8).

Site Layout

Panel 4-North

Panel 4-North was the first panel to be mined during the shield demonstration project. This panel was 168 m (550 ft.) wide and 479 m (1570 ft.) long. The seam height for panel 4-North varied from 3 m to 3.4 m (10 ft. to 11 ft.). The panel was blocked out with three tailgate entries and two headgate entries. Ventilation for the panel was obtained by intaking through the second headgate entry and returning air through the center tailgate entry to a ventilation raise behind the 4-North starting rooms. This system enabled the tailgate man to work in fresh air by directing the return air to the last open break at the tailgate with line brattice. Approximately 5,000 cfm of belt air is allowed to bleed up the tailgate entry to provide a fresh air base for the tailgate man. The ventilation circuit for panel 4-North is shown on figure 9. All three demonstration panels used belt haulage. Section belts in the headgate fed onto the prospect belt. This belt dumped onto the 3rd Left belt which fed the main belt. Figure 10 shows the conveyor system. Roof control in the demonstration area varied with the type of roof encountered. When developed panels, roof bolts and steel mats are used in areas with good roof. When fair or poor roof is encountered, steel H beams and posts are installed. Cribs are installed in crosscuts where additional support is needed. Figure 11 and 12 indicates the areas of good, fair, and poor roof conditions in the demonstration area. Good and bad roof is determined by the geologic units present and the presence of faults, joints, and slips. During mining of the longwall panels, additional support is installed in the headgate and tailgate entries as needed. This additional support consists of hydraulic props, shields in the gate entries, posts, H beams, cribs, and additional roof bolts and mats. Specific roof control for the demonstration will be discussed later in this report.

Panel 5-North

Panel 5-North was the second panel to be mined during the demonstration project. This panel was wider at the beginning than at the end of the panel. 5-North was 135 m (444 ft.) wide at the beginning and 126 m (414 ft.) wide at the end of the panel. The panel was 604 m (1980 ft.) long. The seam height for panel 5-North varied from 2.9 m to 3 m (9.5 ft. to 10 ft.). The panel was blocked out with two headgate and two

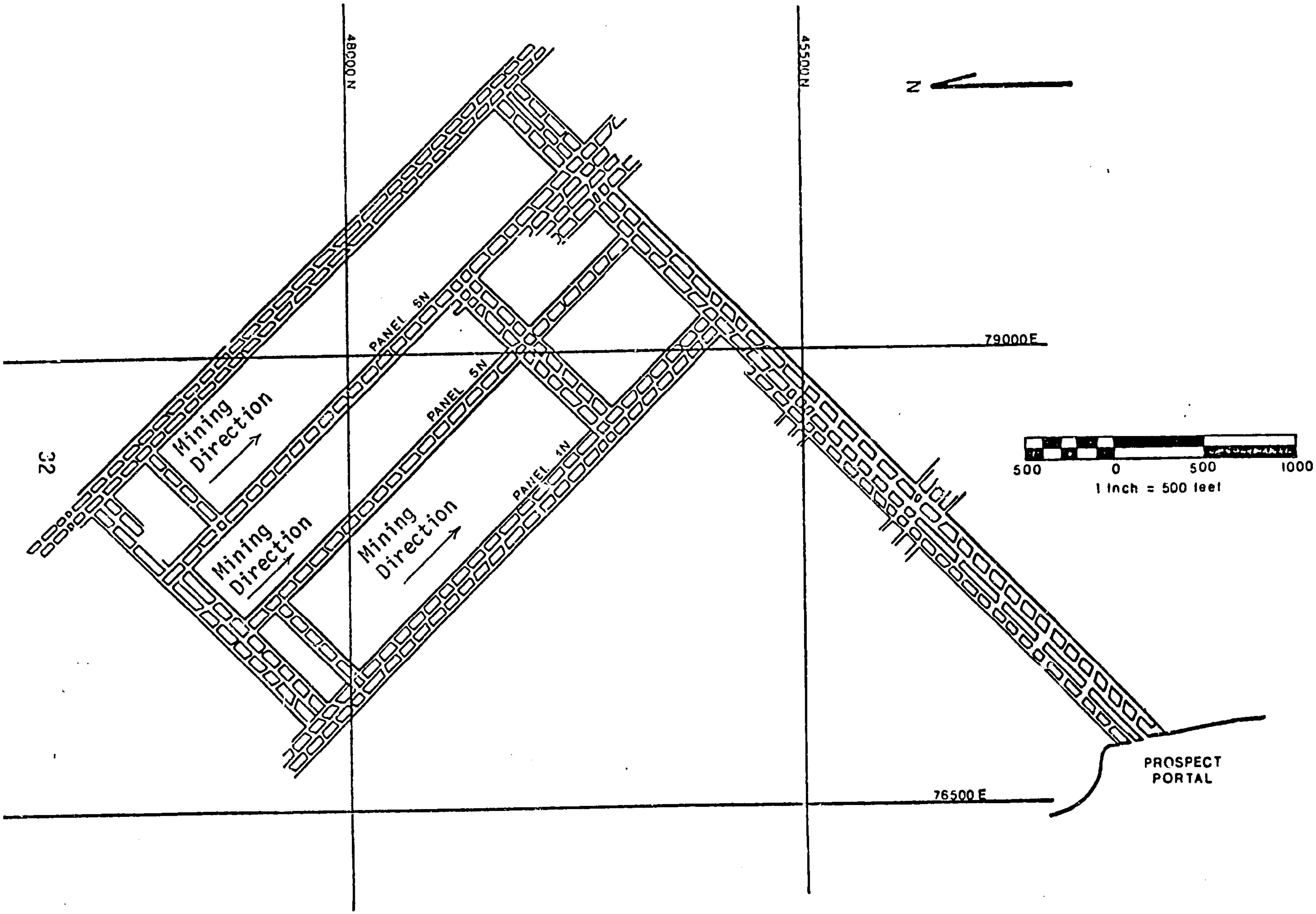


FIG 8 PANEL LOCATION MAP

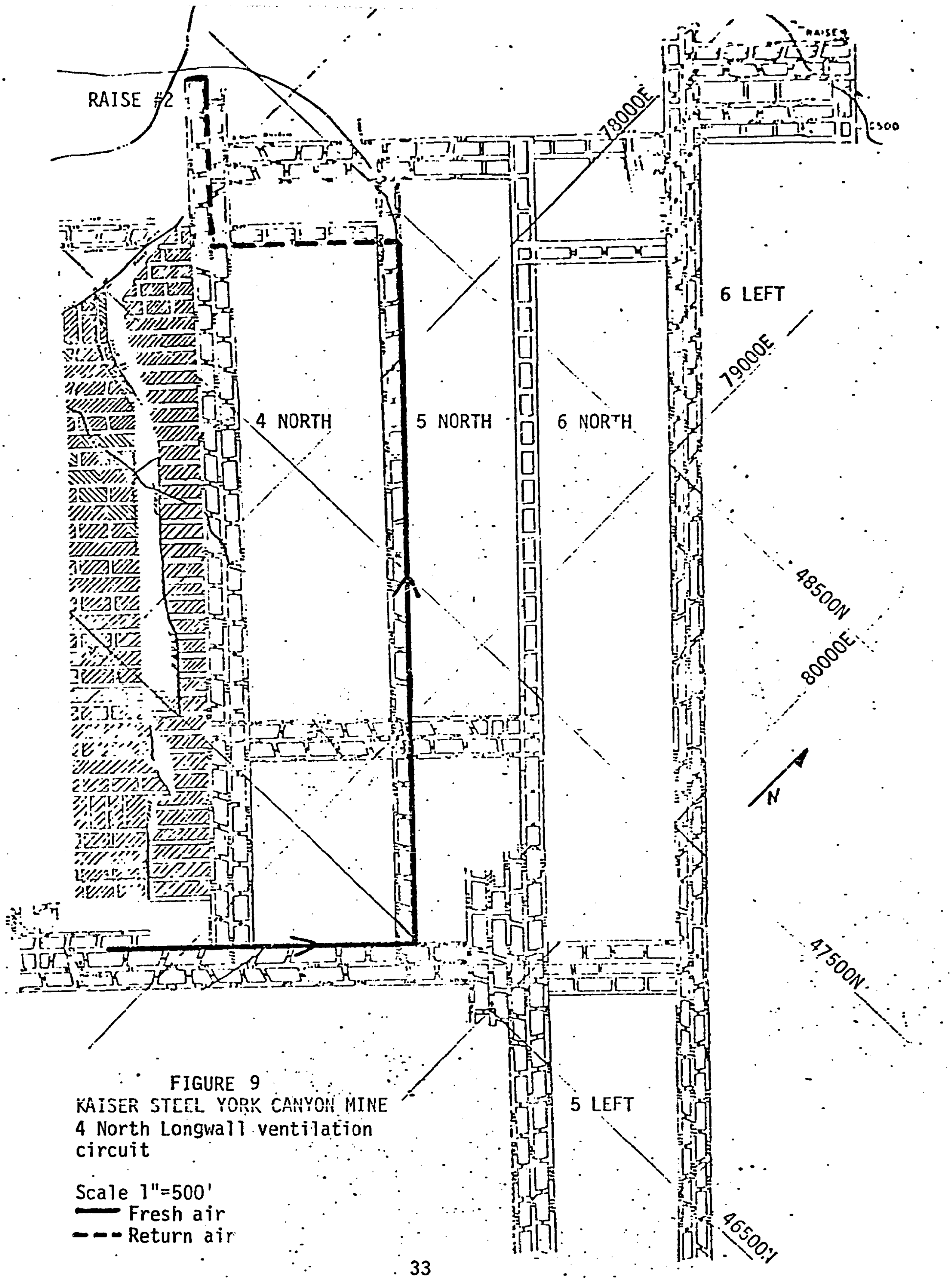
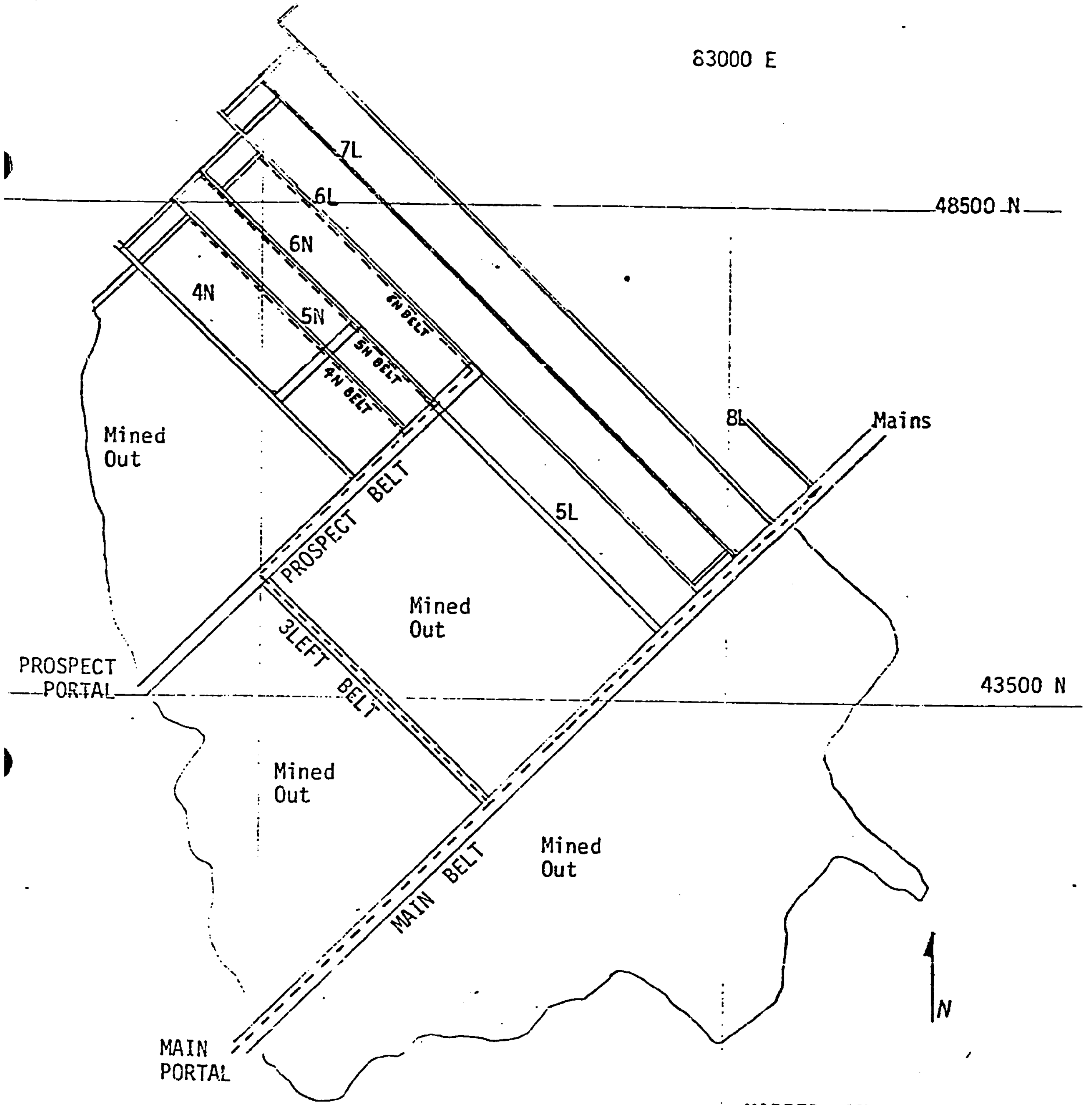


FIGURE 9
KAISER STEEL YORK CANYON MINE
4 North Longwall ventilation circuit

Scale 1"=500'
Fresh air
Return air



KAISER STEEL YORK CANYON
Scale 1"=1500'
---- Conveyor Belt

FIGURE 10 CONVEYOR BELT HAULAGE SYSTEM FOR 4N, 5N, AND 6N SHIELD LONGWALL PANELS

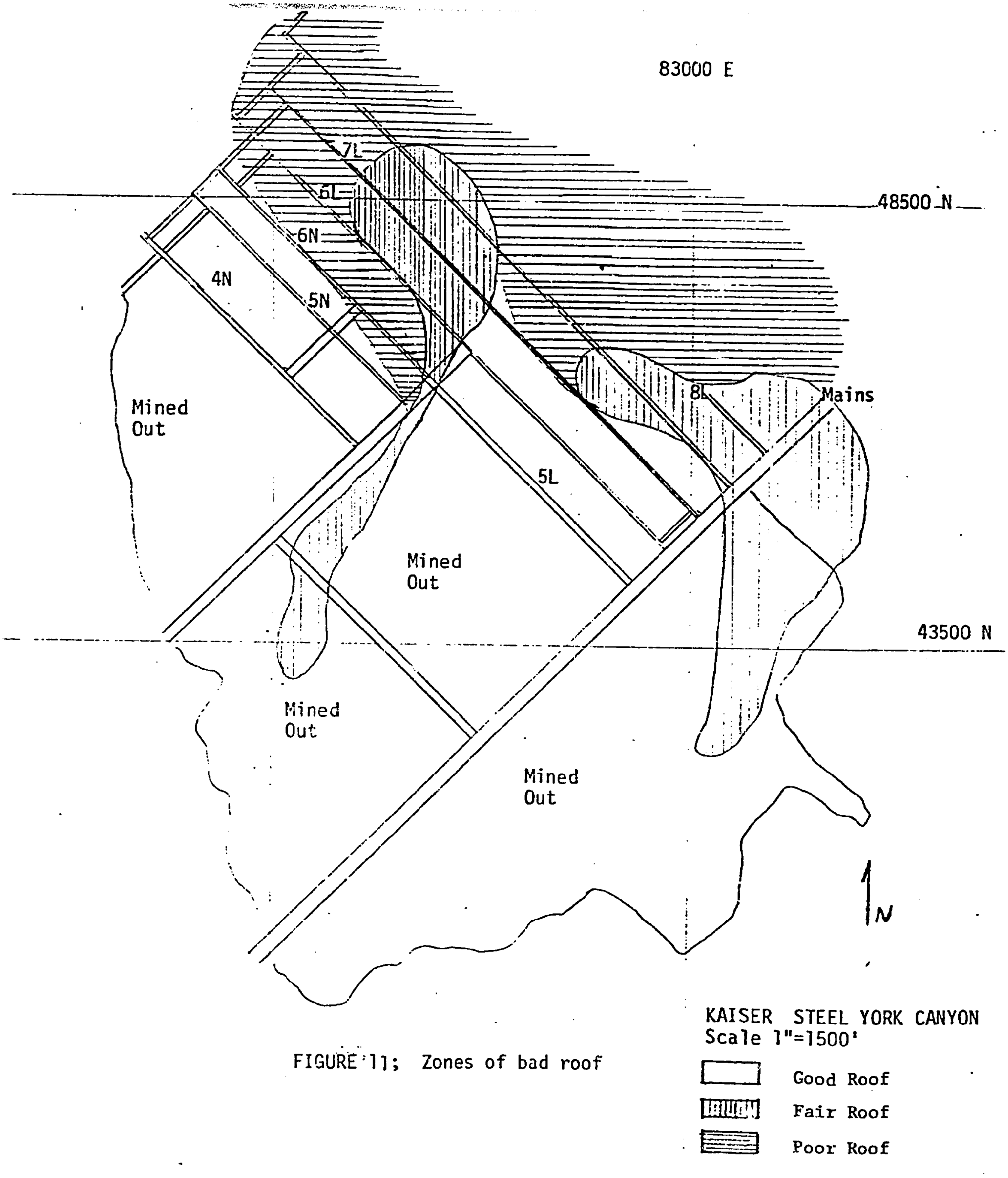
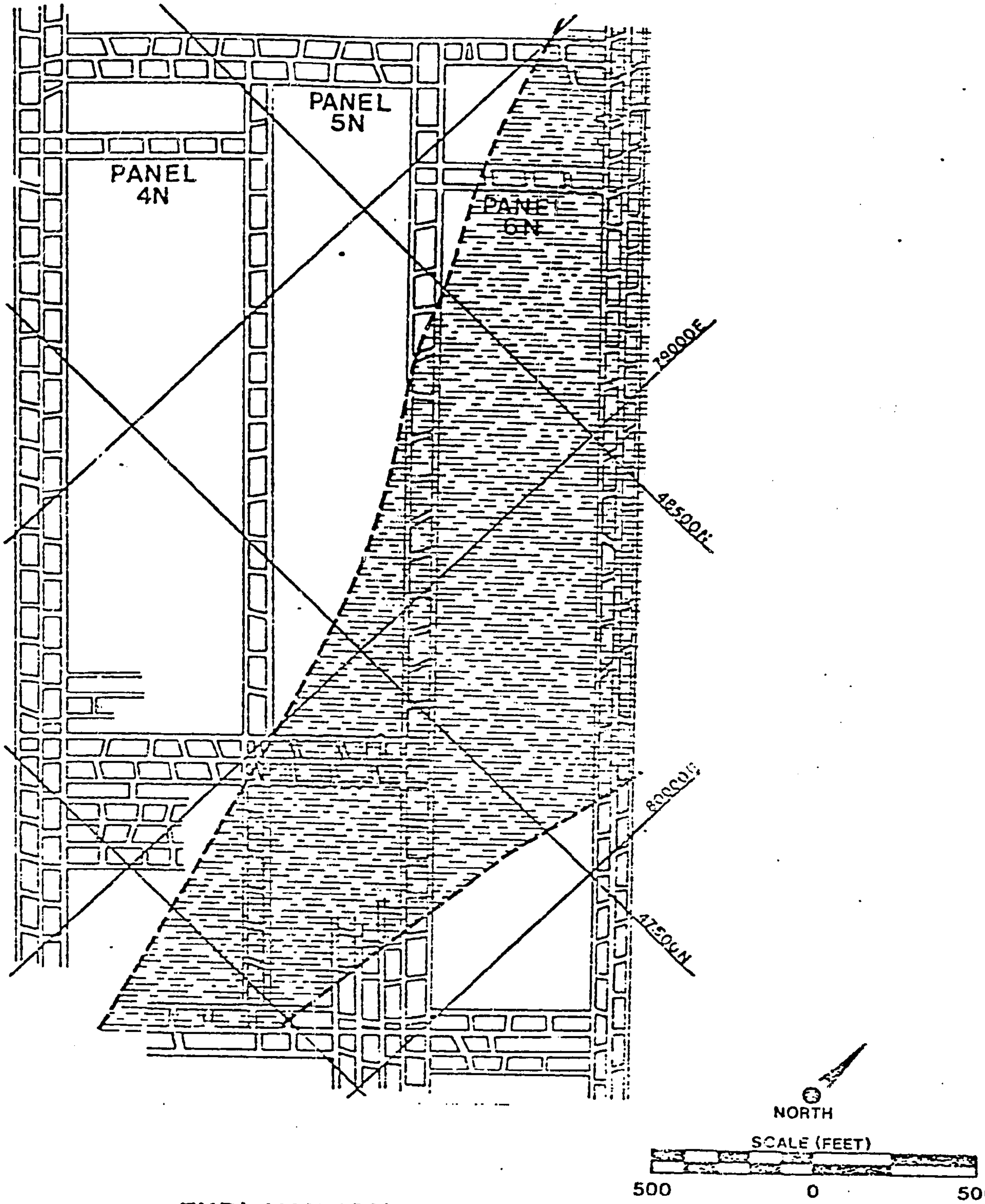


FIGURE 11; Zones of bad roof



EXPLANATION

Bad roof

ZONES OF BAD ROOF

FIGURE 12

tailgate entries. Ventilation for the panel was obtained by intaking through the second headgate entry and returning air down the tailgate entry to the ventilation raise. This ventilation system kept the tailgate man in return air at all times. Figure 13 shows the ventilation system for 5-North.

Panel 6-North

Panel 6-North was the final panel to be mined in the demonstration. This panel was 15 m (500 ft.) wide and 774 m (2540 ft.) long. The seam height for panel 6-North varied from 2.1 m to 3 m (7 ft. to 9.8 ft.). The panel was blocked out with three headgate and two tailgate entries. Ventilation for the panel was obtained by intaking through the center headgate entry (figure 14). From here, it exited to the ventilation raise, as did the 5-North air.

Site Equipment

Panel 4-North

Panel 4-North utilized 116 Hemscheidt 320 HSL, caliper type, 352 ton capacity, hydraulic shield supports. These supports were adjusted to the high seam height position. A 300 HP, water cooled Anderson Mavor double-drum shear was used to cut the coal. This shearer had 152 cm (60 in.) drums, hand operated cowls without cowl extensions, and a mechanical type haulage system. An Eickoff EKF-3, 30 mm, single chain armored face conveyor was used to move the coal at the face. The face conveyor was powered by two 150 HP motors and one 125 HP motor driving through fluid couplings. A Dowty Meco armored stage loader fed onto a 91 cm (36 in.) Continental conveyor belt. A Continental conveyor belt take-up unit capable of storing 112 m (360 ft.) of belt was installed at the end of the panel. Belting was removed weekly before the take-up unit was completely filled. The belt take-up motors ran off a 440 volt A. C. power supply. Hydraulic power was furnished by a dual motor-pump power pack utilizing two 75 HP motors and triplex piston Uracca pumps. The power pack was supplied by Hemscheidt and supplied a working pressure of 315 bars or 4500 psi. A 946 liter (250 gallon) tank was used to store the hydraulic fluid. The hydraulic fluid consisted of a dilute emulsion of 97% water and 3% soluble oil. The lump breaker used on Panel 4-North was fabricated at York Canyon's maintenance shop. It was a rotary feeder breaker similar to those used in belt feeder breakers. An Ocean Energy lighting system, utilizing flourescent luminaires, was installed on the shields. Electrical supply was furnished by Service Machine equipment. All electric motors were 950 volts except for the pump motors which were 480 volts A. C.

Panel 5-North

Panel 5-North utilized the same equipment as panel 4-North except for the shearing machine, lump breaker, and number of Hemscheidt shields. Since the 5-North face was narrower than the 4-North face, only 93 Hemscheidt 320 HSL caliper type shields were used. The Anderson Mavor shear-

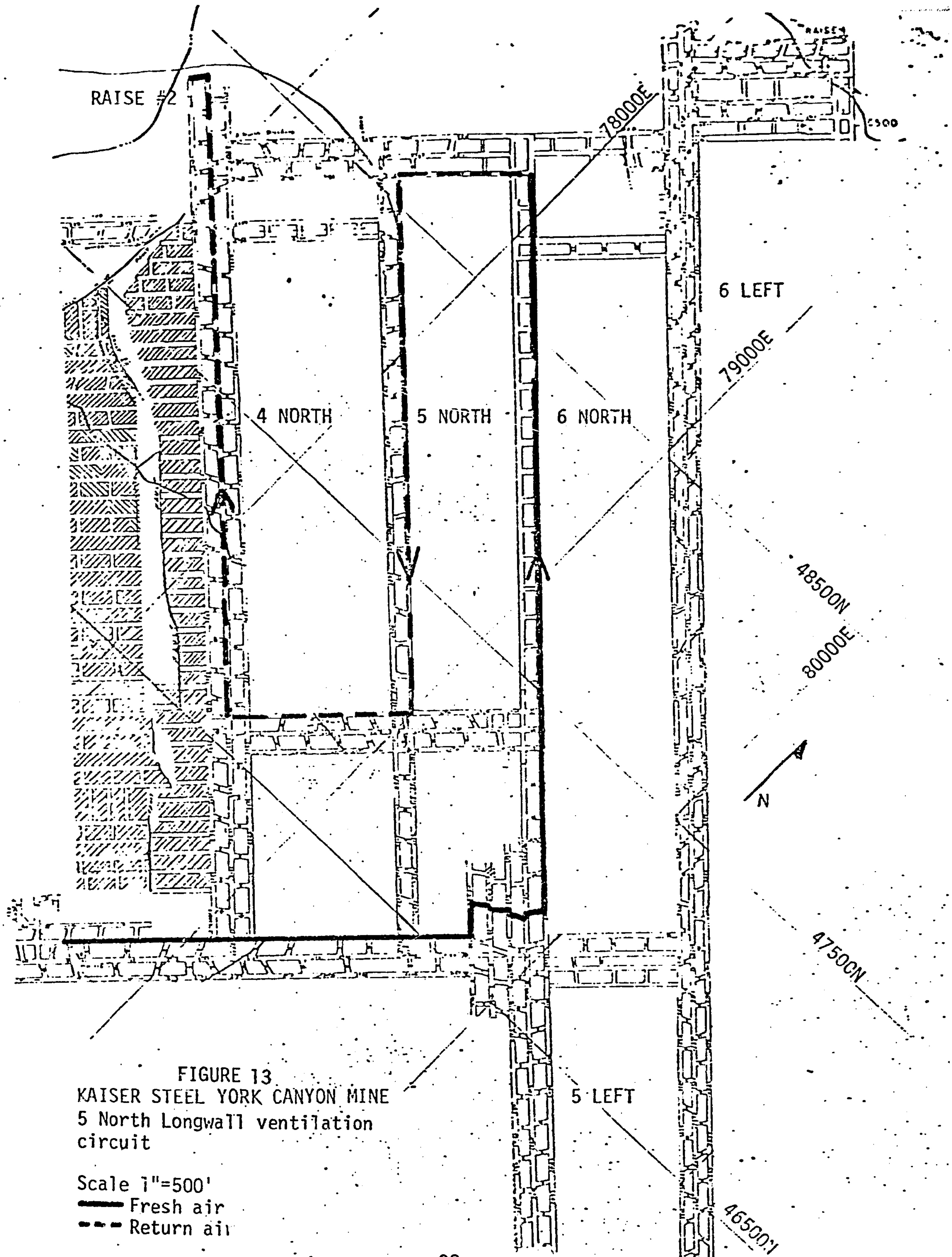


FIGURE 13
KAISER STEEL YORK CANYON MINE
5 North Longwall ventilation circuit

Scale 1"=500'
Fresh air
Return air

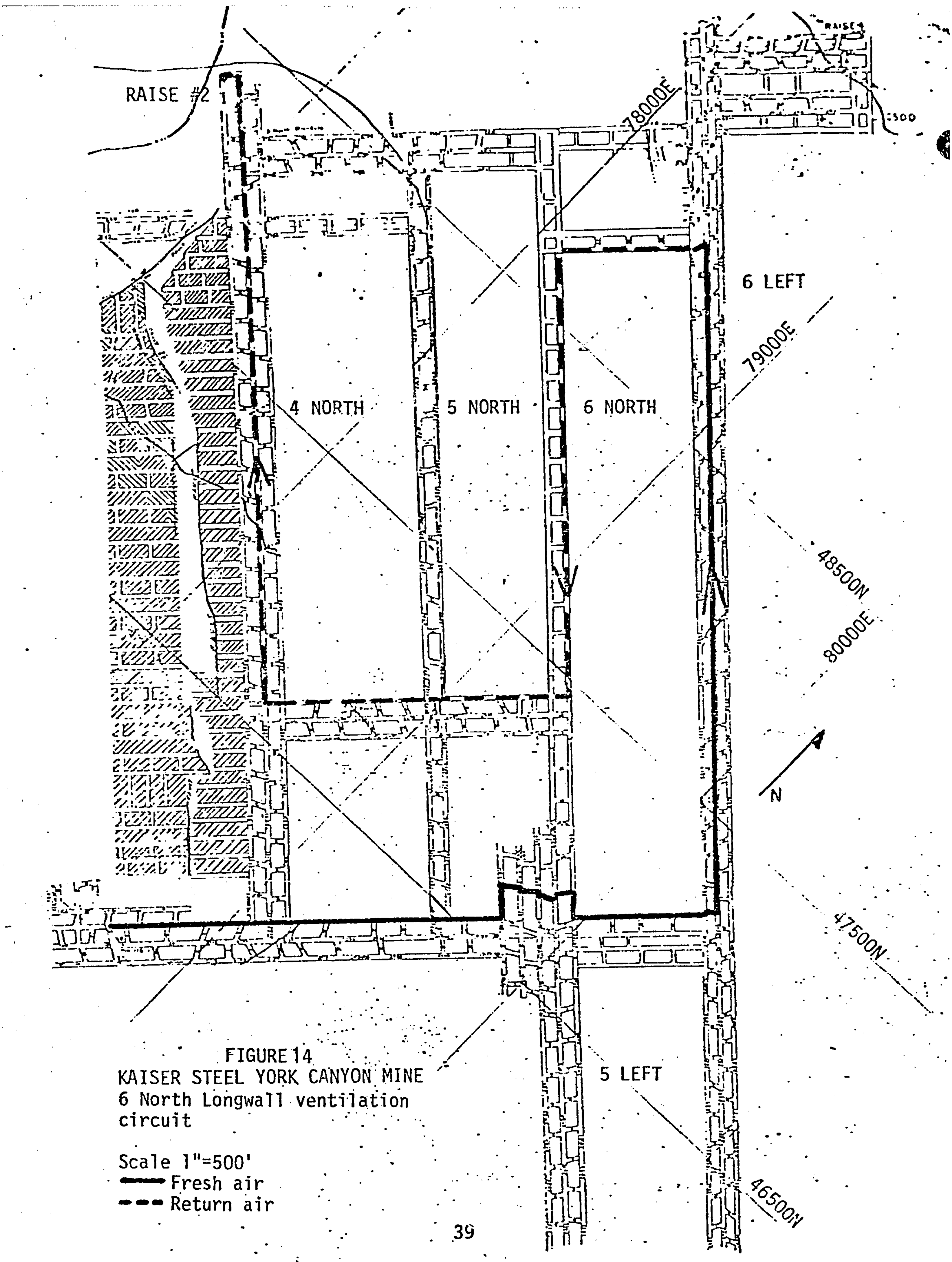


FIGURE 14
KAISER STEEL YORK CANYON MINE
6 North Longwall ventilation circuit

Scale 1"=500'
Fresh air
Return air

ing machine used on 4-North panel was replaced with an Eickoff EDW 300-L double drum shearing machine. The Eickoff shearing machine utilized a 1.5 m (5 ft.) diameter drum. This machine was rated at 300 KW or approximately 400 HP and had a hydraulic haulage system. Since the 4-North lump breaker had problems accepting large lumps, it was replaced by a Klockner Ferromatik SB63 impact roll sizer which would accept larger lumps.

Panel 6-North

Panel 6-North utilized the same equipment as 5-North except for the number of shields. A total of 99 Hemscheidt 320 HSL caliper type shields were used on the 6-North face. Because the expected mining height on 6 North was less than 254 cm (100 in.), the shields were adjusted to their lower height position. To accommodate the lower height, two changes were made in the shields. The hinge pin which connects the gob shield to the base of the shield was moved to its lower position. In addition to this, the legs were set to the back position where they connect to the base. These two changes would result in better roof resistance and more working room for the shearer and operators at lower seam heights. Extracted seam heights were much greater than 254 cm (100 in.) due to geologic complications and these changes resulted in very poor roof control on panel 6 North. These problems will be discussed in detail later in this report. In addition to adjusting the shields for lower height, foam rubber cushions were installed between the roof canopies and gob shields for panel 6-North. These cushions are designed to keep broken rock from accumulating under the roof canopies and impairing proper operation of the shield. This becomes a problem at lower seam heights due to the angle of the gob shield. In addition to the 99 Hemscheidt 320 HSL caliper type shields, six Hemscheidt 320 lemniscate G-type shields were used on the 6-North panel. Three of these shields were located in the headgate entry and three were located in the tailgate entry. These shields were used because the entries were driven at lower than full seam height. With H beams supporting the entries, the clearance in some areas would have been too low for the caliper type shields to negotiate. The G-type shields have a lower operating range and allowed for greater clearance and operating room.

Site Geology

The geology of the demonstration area is discussed in detail in the final technical report "Rock Mechanics Instrumentation Program for DOE's Demonstration of Shield-Type Longwall Supports at York Canyon Mine, Raton, New Mexico".

The overburden above the test panels consists of soil and rock. The soils are basically silty clays that vary in thickness from 0.3 m (1 ft.) over topographic highs to 7.6 m (25 ft.) in gully bottoms. The rock overburden consists of varying quantities of five basic lithologies. In order of decreasing quantity, these basic lithologies are: shale, siltstone, sandstone, carbonaceous shale, and coal. In general, the shale content increases along the panels in the direction of face advance. Panel 4 North generally had the most shale overburden and panel 5-North had the most sandstone overburden. Figures 15 and 16 show general near seam stratigraphy for the demonstration panel.

The coal seam is essentially flat lying in the demonstration area with a strike of N10°W. The face cleat is consistant throughout the demonstration area and trends east-west with a near vertical dip. The spacing averages 0.6 m to 0.9 m (2 ft. to 3 ft.). The butt cleat is variable depending on the main seam thickness. Trends vary from N55 W where the seam is thick to N10°W where the seam is thin. Dips are near vertical and the spacing averages 0.3 m to 0.6 m (1 ft. to 2 ft.). A third joint orientation occurs locally and trends N20°E with near vertical dips. The seam is divided by a shale split into an upper and lower bed. The lower or main seam thins toward the east as the shale split thickens from 15 cm (6 in.) over panel 4-North to 9 m (30 ft.) at the southeast end of panel 6-North. The coal above the shale split is a low quality coal and is consistantly about 0.3 m (1 ft.) thick. Photograph 3 shows the coal seam, shale split, roof coal, and main sandstone.

The main roof over the upper seam is shaley siltstone grading to sandstone. This unit increases from 1.5 m (5 ft.) thick over panel 4-North to 7.6 m (25 ft.) thick over panel 6-North. This unit exhibits a major joint set trending east-west and dipping vertically. A minor joint set trends N12°W and has a steeply angled northerly dip. The sandstone is very competent but does cave well behind the shields. A initial span of 15.2 m to 30.5 m (50 ft. to 100 ft.) is required at the start of a panel before caving begins.

The floor is composed of a thin shale unit averaging about 0.3 m (1 ft.) thick. When wet, this unit becomes unstable and creates problems. Because of this, it is usually removed with the coal seam. Under the soft shale is a strong sandstone unit which makes an excellent floor. This unit is generally thicker than 3 m (10 ft.).

Faulting in the demonstration area exhibits three trends: north-south, N45°W, and a random distribution. There were four faults which intersected the three demonstration panels. These faults are shown on figure 17. The faults encountered are normal faults with offsets from 0.3 m to 3.7 m (1 ft. to 12 ft.).

The overburden thickness varied widely over the demonstration area but generally increases in depth from panel 4-North to panel 6-North. The cover over panel 4-North ranged from 61 m to 140 m (200 ft. to 460 ft.). The lowest point occurred at about the middle of the panel over the southeast corner of the panel. The cover over panel 5-North ranged from 98 m to 174 m (320 ft. to 570 ft.). Again, the lowest cover was on the tailgate side about 213m (700 ft.) from the panel starting position. The highest cover occurred on the headgate side about 396 m (1300 ft.) from the panel starting position. Over panel 6-North, the overburden ranged from 148 m to 244 m (485 ft. to 800 ft.). The minimum cover occurred on the headgate side at the panel starting position. The maximum occurred at the southeast corner of the panel.

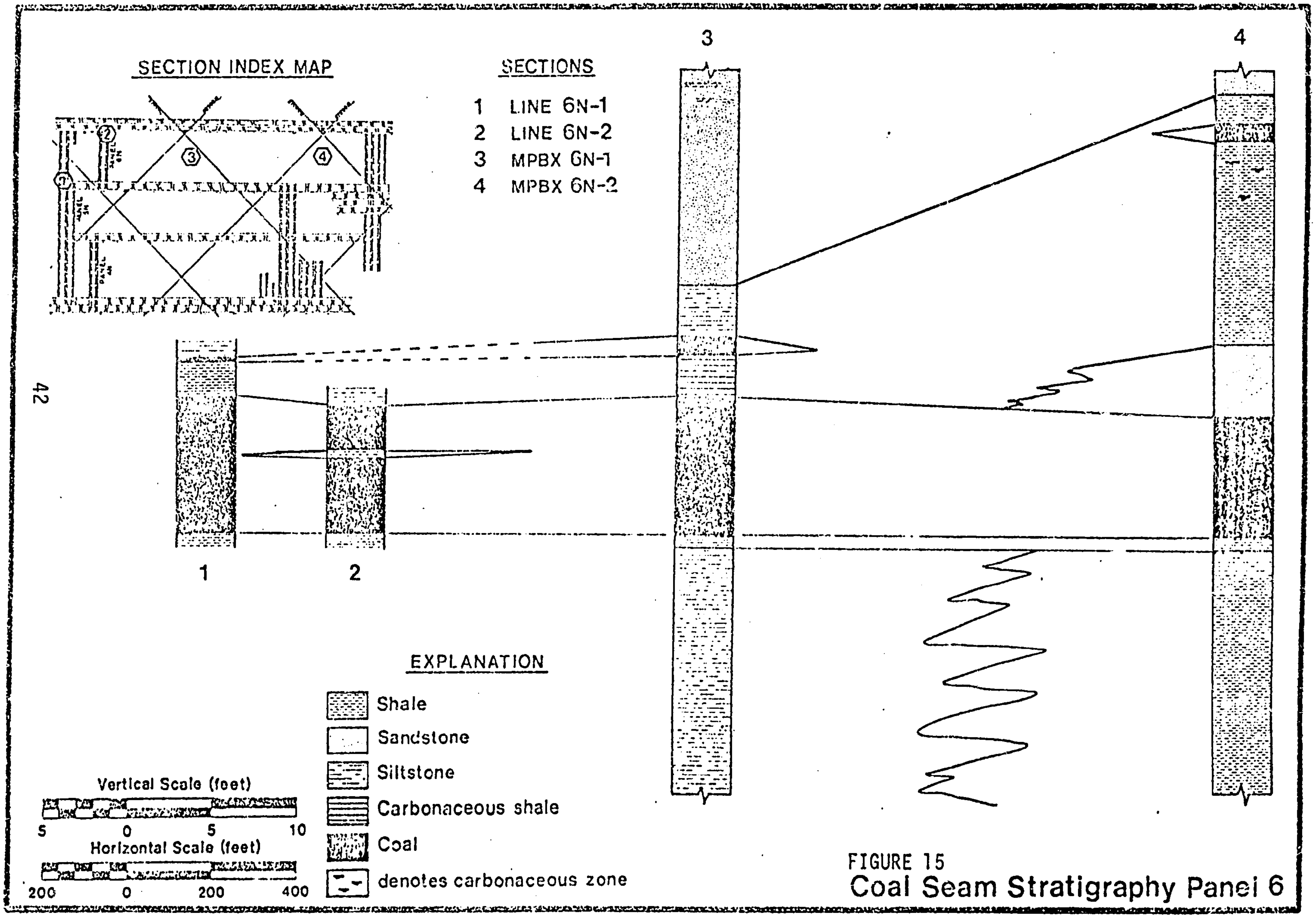


FIGURE 15
Coal Seam Stratigraphy Panel 6

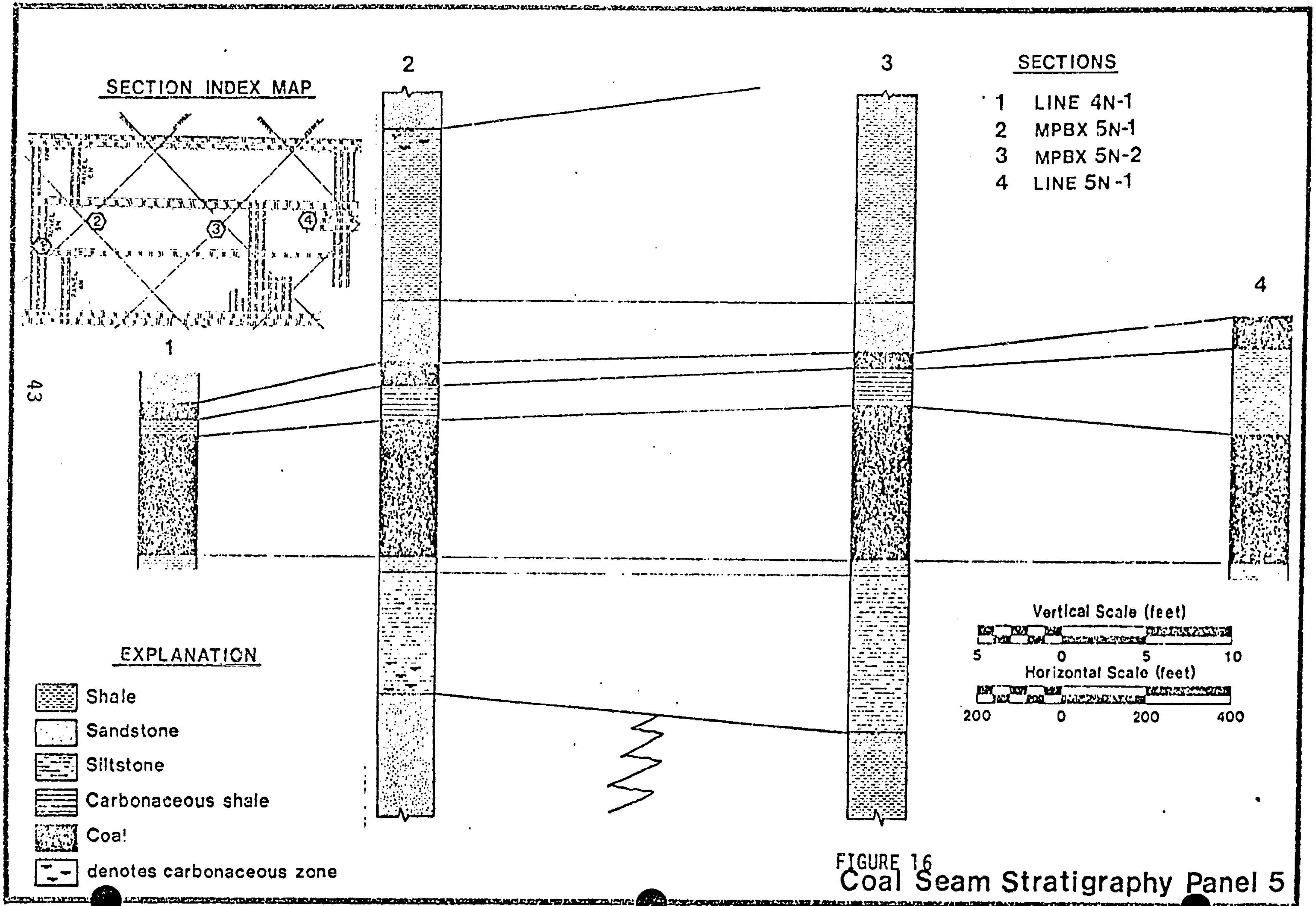
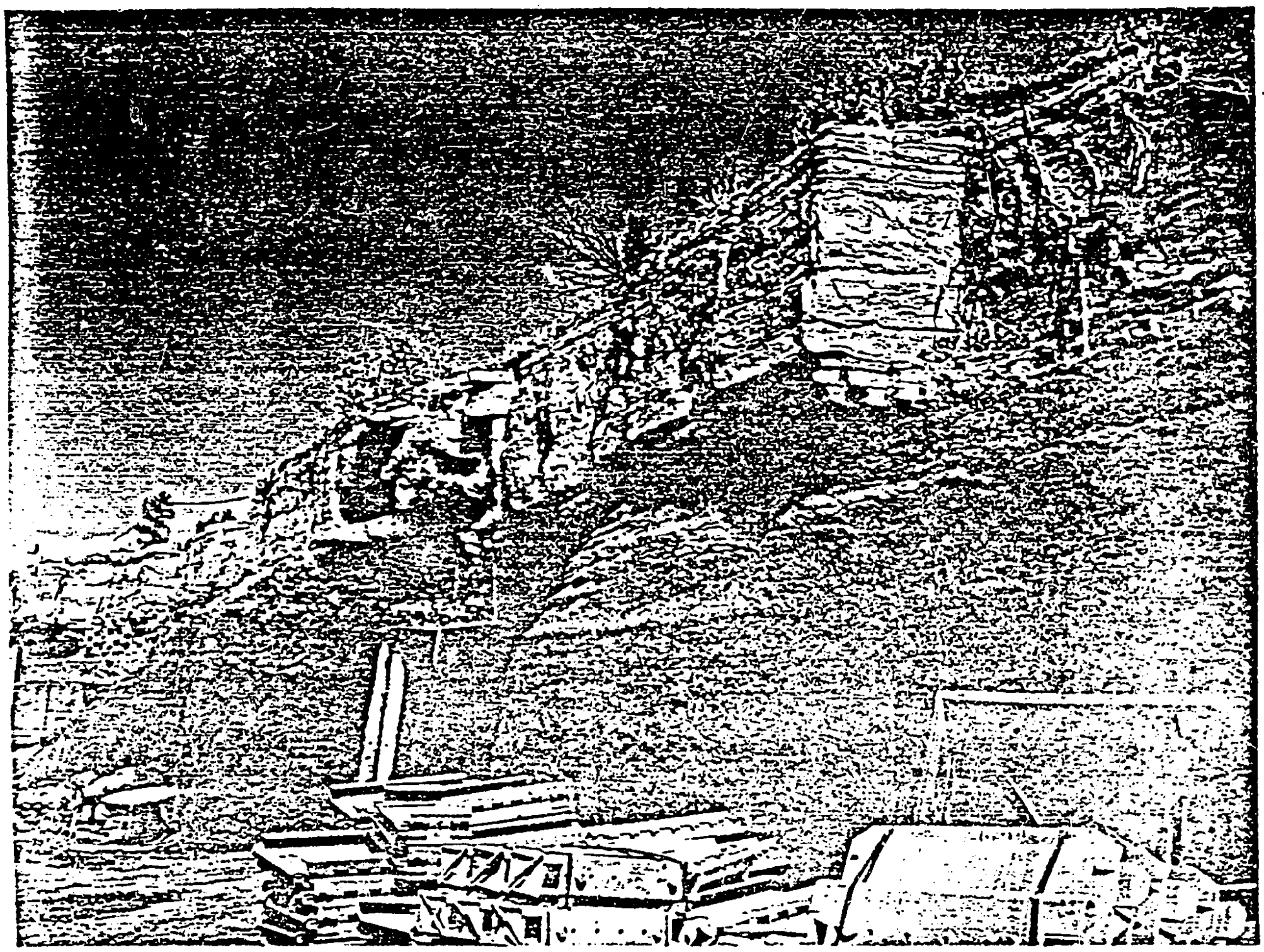
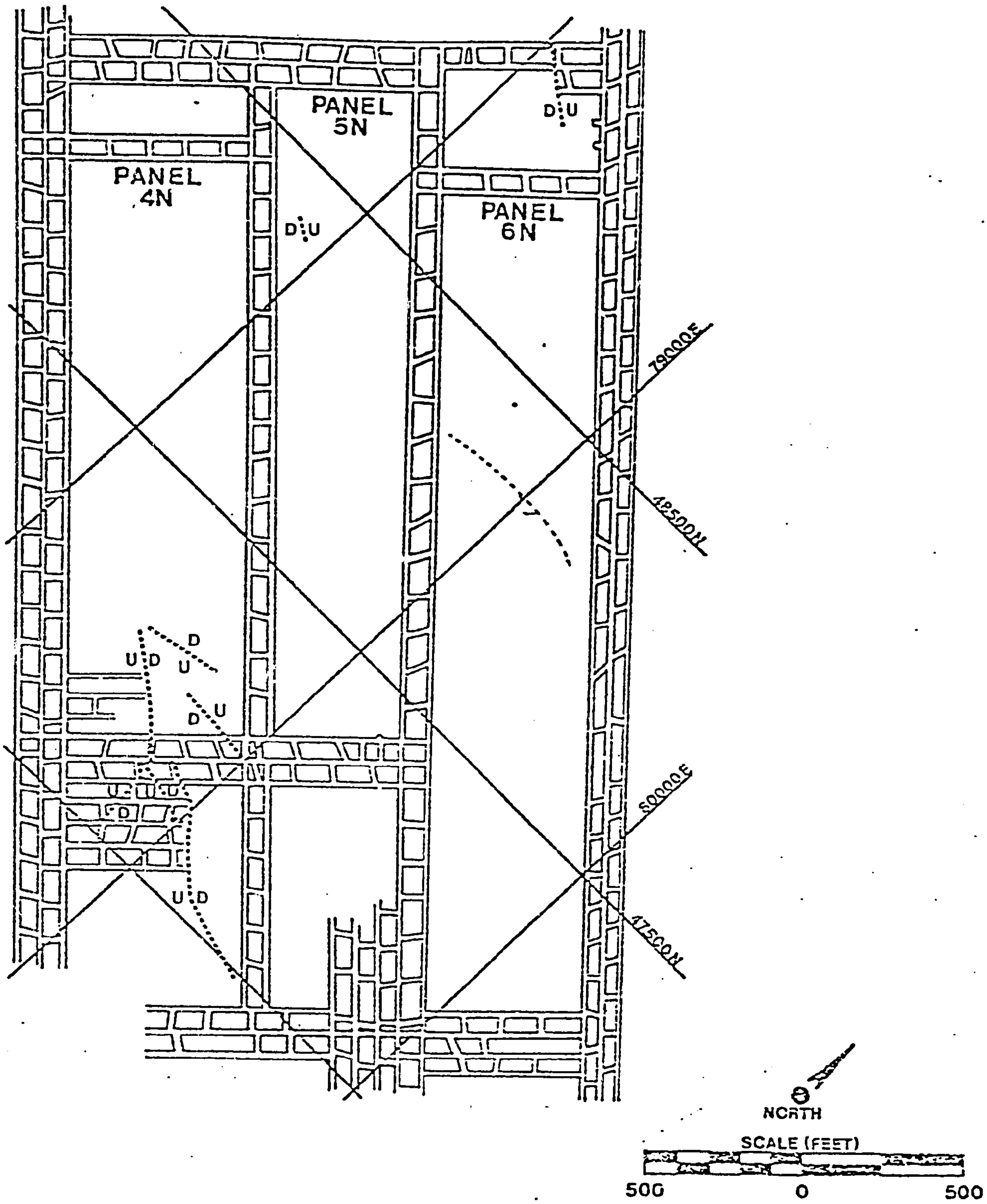


FIGURE 16
Coal Seam Stratigraphy Panel 5



Photograph 3; York canyon coal seam showing main seam, roof shale split, roof coal seam, and main roof sandstone unit.



EXPLANATION

- ······ Fault trace
- u upthrown
- d down thrown

FAULT MAP

FIGURE 17

OPERATING EXPERIENCE

Various aspects of the operating experience for the three panel longwall shield demonstration are discussed in this section. The specific topics discussed are production, ground control, face operations, panel termination and moves, and working conditions. Appendix 1 shows a chronologic log of the operations on the demonstration panels.

Production

Panel 5-North was the most productive of the three demonstration panels and Panel 6-North was the least productive. Figure 19 shows the monthly face advance for all three panels.

Panel 4-North

Panel 4-North began operations on May 9, 1975 and ended production on May 14, 1976. During this time a block of coal 167m (550 ft) wide and 479m (1570 ft) long was mined yielding 330,968 metric tons (364,904 short tons) of raw coal. Coal was mined on two shifts per day and maintenance was performed on the third shift. Average production for panel 4-North was 817 metric tons (901 short tons) per production shift. This value reduces to an average of 2.3 shears or 1.7m (5.7 ft) of advance per production shift. The highest monthly production was in January 1976. During this month a total of 37,494 metric tons (41,339 short tons) of coal was mined. This value reduces to an average of 1041 metric tons (1148 short tons), 2.9 shears or 2.2m (7.3 ft) of advance per production shift. The highest production for a working day occured on October 17, 1975. On this date 2987 metric tons (3293 short tons), 8.4 shears, and 6.4m (21 ft) of advance was achieved.

Panel 5-North

Panel 5-North began operations on July 30, 1976 and ended production on May 12, 1977. During this time a block of coal 135m (444 ft) wide at the beginning, 126m (414 ft) wide at the end, and 604m (1980 ft) long was mined. This panel yielded a total of 313,965 metric tons (346,158 tons) of coal. As on Panel 4-North, production took place two shifts per day and maintenance was performed on the third shift. Average production for Panel 4-North was 981 metric tons (1082 short tons) per production shift. This value reduces to an average of 3.0 shears or 2.3m (7.5 ft) of advance per production shift. The highest monthly production was in October 1976. During this month a total of 32,673 metric tons (36,016 short tons) of coal was mined. This value reduces to an average of 1256 metric tons (1385 short tons), 3.8 shears, or 2.9m (9.5 ft) of advance per production shift. The highest production for a working day occured on October 21, 1976. On this date 3791 metric tons (4179 short tons), 11.5 shears, and 8.7m (28.7 ft) of advance was achieved.

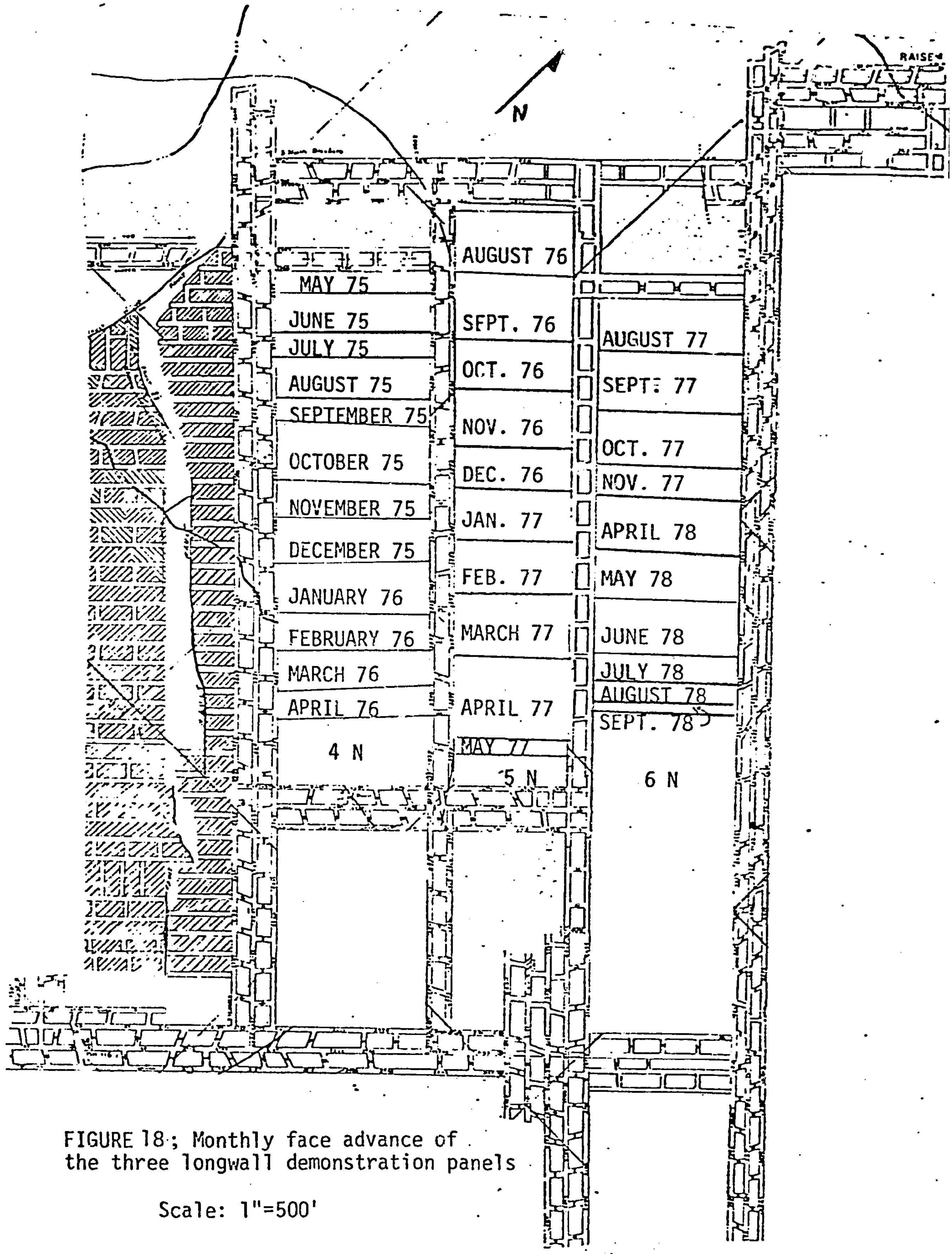


FIGURE 18; Monthly face advance of the three longwall demonstration panels

Scale: 1"=500'

Panel 6-North

Panel 6-North began operations on August 1, 1977 and ended production on September 29, 1978. During this time a block of coal 152m (500 ft) wide and 453m (1486 ft) long was mined yielding 257,518 metric tons (283,867 short tons) of coal. This panel was terminated early due to operational and ground control problems. Coal on this panel was produced on two production shifts per day and sometimes on the third shift after all maintenance had been completed. Average production for panel 6-North was 593 metric tons (654 short tons) per production shift. This value reduces to an average of 1.5 shears or 1.2m (3.8 ft) of advance per production shift. The highest monthly production was in August 1977. During this month a total of 35,802 metric tons (39,465 short tons) of coal was mined. This value reduces to an average of 874 metric tons (963 short tons) 2.3 shears or 1.7m (5.7 ft) of advance per production shift. The highest production for a working day occured on September 20, 1977. On this date 2841 metric tons (3132 short tons), 7.4 shears, and 5.6m (18.4 ft) of advance was achieved.

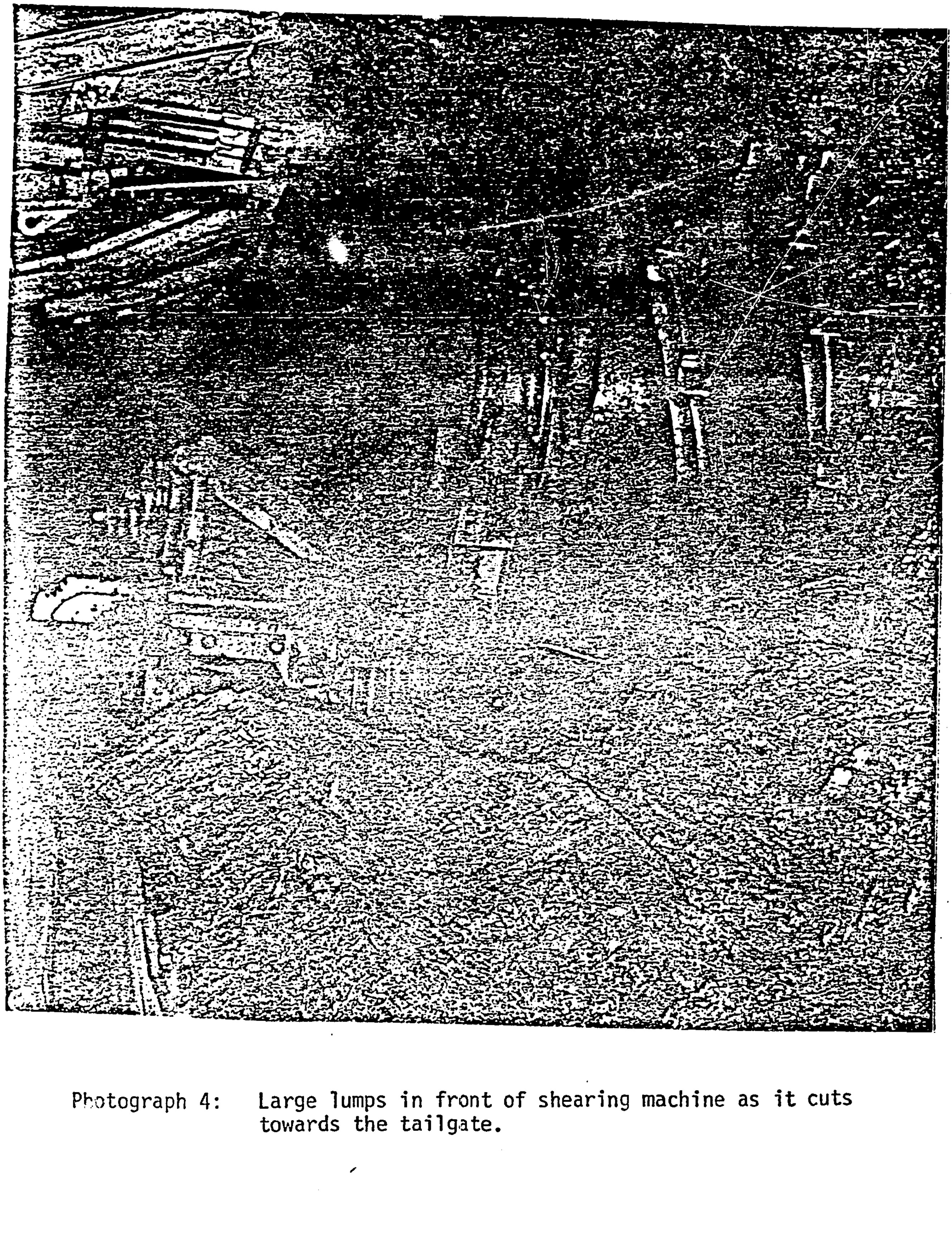
Ground Control

Panel 4-North

With the exception of large coal lumps falling from the face, panel 4-North was relatively free of ground control problems.

The initial cave on panel 4-North occurred after a total span of 26m (85 ft) had been mined. After the initial cave, the roof caved well behind the shields. The gob remained tight against the shields over the entire length of the face except at the gate entries. In these areas, the cave commonly lagged 6m to 15m (20 to 50 ft) behind the shields.

The face started showing the first signs of pressure just before the initial cave. At this time large lumps of coal began falling from the face just ahead of the shearing machine. These lumps ranged in size up to a maximum of .6m by .9m by 1.8m (2 ft by 3 ft by 6 ft). Photograph 4 shows these lumps in front of the shearing machine. These large lumps adversely affected production in two ways. The large blocks of coal would become wedged along the face conveyor or at the stage loader stopping the flow of coal. Mining had to cease until the blockage was broken up. The large lumps also prevented the shearer from cutting towards the tailgate. In this case, the coal lumps would build up in front of the shearer restricting the flow of coal and inhibiting proper tramming. In an attempt to control the lumps, wooden dowls were installed along the face. This test appeared to keep the lumps pinned to the face long enough for the shearer to cut them but proved to be uneconomical. The time spent drilling the holes and inserting the dowls cost more production time than breaking the lumps.



Photograph 4: Large lumps in front of shearing machine as it cuts towards the tailgate.

Panel 4-North was free of roof problems with the exception of one minor problem. On August 20, 1975 face advance - 152 m (500 ft.), a weak roof and soft floor resulted in lateral loading of the first two shields in the headgate. These shields began leaning towards the chain pillar and a large amount of cave material fell between the second and third shield. To upright the leaning shields, steel beams and wire mesh were placed over shields 1, 2, and 3. The leaning shields were then pulled upright with a come-along and an air wrench.

Floor heave may have been partially responsible for conveyor hangups which plagued operations throughout the three panel demonstration. The configuration of the flights cause them to protrude below the pan under the conveyor which could have caused some hangups. Although it was not tried on the demonstration panels, a cover underneath the conveyor pan might have eliminated some of the problems.

Two faults were encountered near the end of panel 4-North (figure 18). Offsets for these faults ranged from .3 m to 3.7 m (1 to 12 ft.) on the larger fault and from .3 m to 1.5 m (1 to 5 ft.) on the smaller fault. There was a minimum of brecciation within the fault zones and only minor problems were encountered in advancing through them. In order for the shearing machine to negotiate the fault, the floor rock on the upthrust side had to be drilled and shot before each pass. The shields upslope from the fault tended to crowd the shields on the lower side of the fault by sliding downhill when advanced. This problem did not adversely affect production to any great extent. Additional roof support in the form of roof bolts and mats was installed in the fault zone as a safety precaution. The panel was terminated 30.5 m (100 ft.) early because of the faults. It was decided that the remaining coal could be recovered more economically using continuous mining room and pillar methods.

Panel 5-North

Panel 5-North was also relatively free of major ground control problems.

The initial cave occurred when a total span of 33.5 m (110 ft.) had been mined. After the initial cave, the caving pattern reacted similarly to that of panel 4-North with the cave lagging up to 15 m (50 ft.) behind the shields in the gate entries.

Minor roof falls reported on the longwall face were related to the weak carbonaceous shale caprock directly above the coal seam. This shale layer averaged about .46 m (1.5 ft.) thick. If the shield canopies were not extended forward immediately after the shearer had passed, the shale would fall in front of the shield canopies. In a few instances this shale was highly fractured and fell through the openings between adjacent shields. This problem was more common in what appeared to be fault zones. Other than this instance, no major problems were encountered when negotiating these zones.

The only major roof fall to occur on panel 5-North took place after the panel had been completed and moving operations were in progress. This fall occurred in an intersection about 30.5 m (100 ft.) ahead of the face in the tailgate entry of panel 6-North. The fall extended 1.5 m to 1.8 m (5 to 6 ft.) up to the rider coal seam.

The fall was secured with roof bolts and by placing extra beams under the brows.

After the first month of production, the face began showing signs of pressure. Large lumps of coal soon became a problem as on panel 4-North. An experiment using wooden dowels and polyurethane resin to control the lump problem proved to be successful, but as in the 4-North experiment, the costs were prohibitive.

Numerous conveyor hangups were attributed to floor heave on panel 5-North.

Approximately 122m (400 ft) from the panel starting position, a small fault appeared on the tailgate side of the panel (figure 20). The maximum displacement of the fault was approximately 1.5m (5 ft). In order for the shearing machine to get through the fault area, the floor was drilled and shot on the upthrust side. The shield supports experienced no difficulty in negotiating this fault.

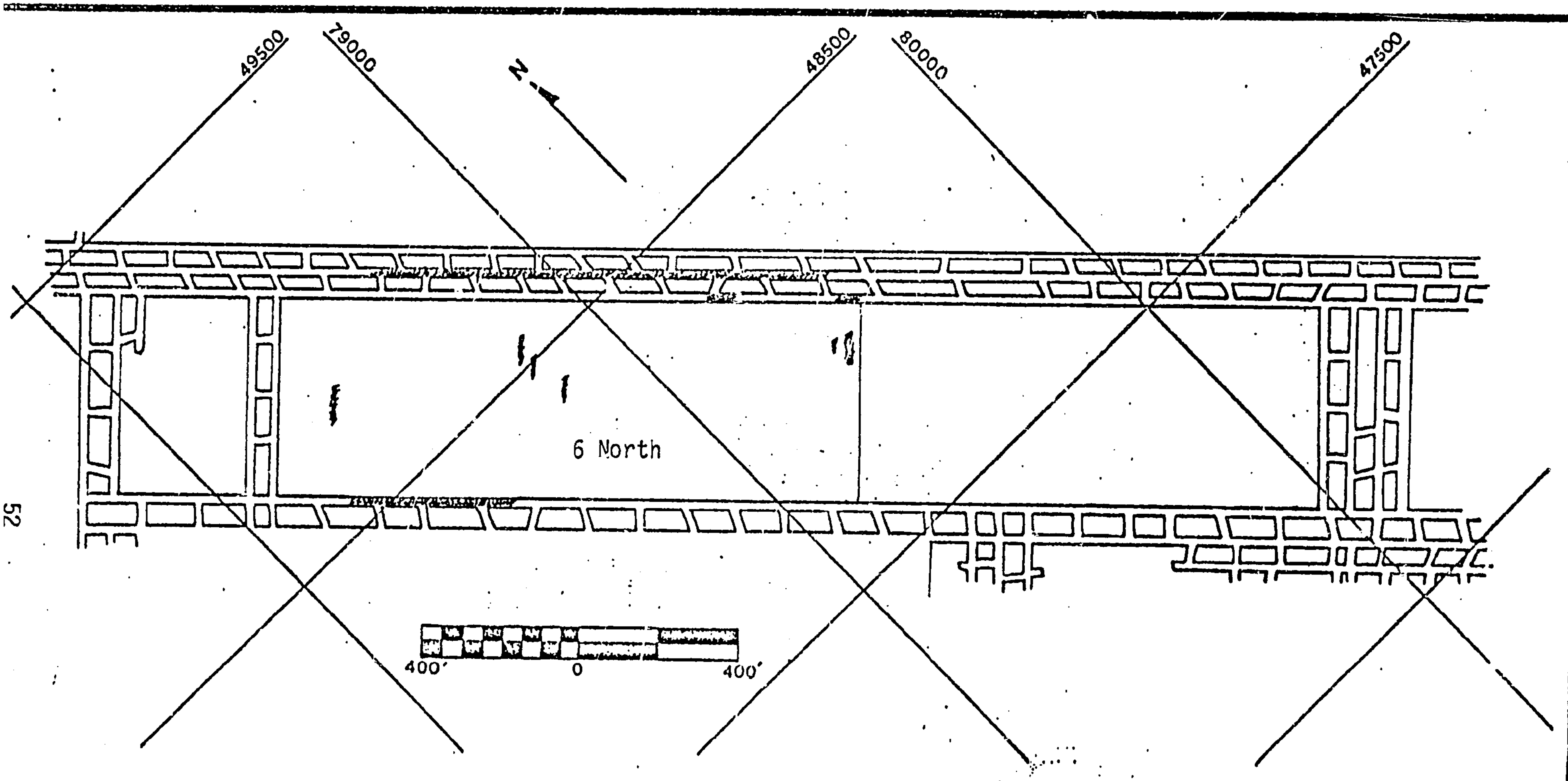
Panel 6-North

Panel 6-North experienced extreme ground control problems throughout the life of the panel. Conditions on this panel were a result of poor roof conditions, operational constraints of the shields, and the close proximity of another operating longwall panel. Figure 19 shows the location of major roof falls on panel 6-North.

The initial cave on panel 6-North occurred when a total span of 26m (86 ft) had been mined. After the initial cave, the gob remained tight against the shields for most of the panel. This included the gate entries which lagged only in the beginning months of production.

The face started showing signs of pressure just after the initial cave. At this time, the shale caprock in front of and over the shields began breaking up forming .3m to .6m (1 to 2 ft) voids in the roof and creating piles of broken rock in the travelway under the shields. This problem grew increasingly worse until the caprock fell continuously from shield number 25 to the tailgate. The shale falling out increased the extracted height by at least .6m (2 ft). Because the shields were set in their low coal position and the extracted height was at least 3m (10 ft) the shields were unable to effectively support the roof. At times the shield canopies were up to 1.5m (5 ft) away from the face. Photograph 5 shows the caprock which fell causing the increased height. As the panel progressed, the shale caprock increased in thickness compounding the extreme height problem. Because of the extreme height and all of the broken rock around the shield legs, the shields were difficult to advance. On several occasions, many of the shields along the face were extended so high that they became unstable and began leaning backwards.

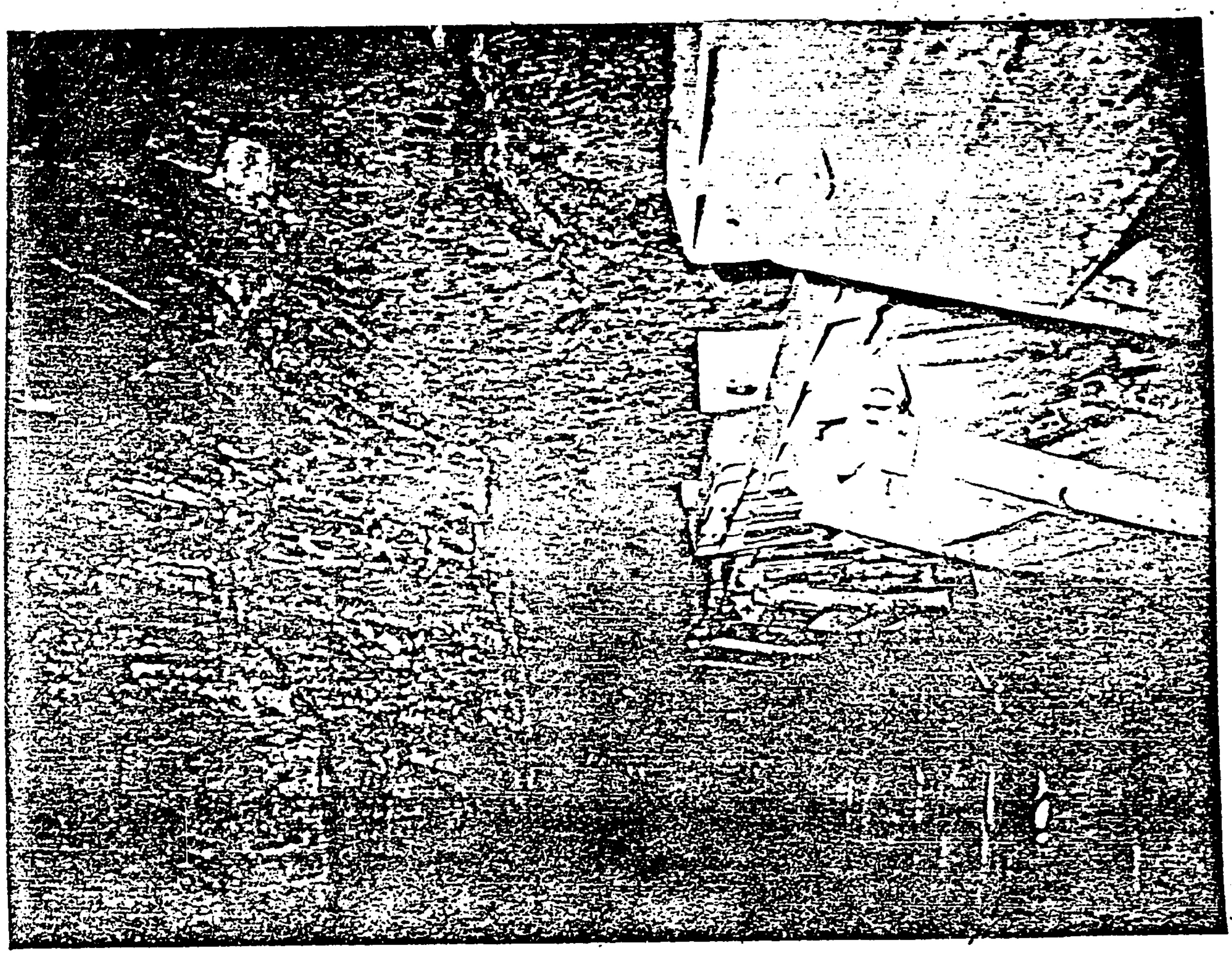
Because the shields were adjusted for low coal and operating beyond their operating limits, they were unable to effectively support the roof. This resulted in several major roof falls along the face and in the gate entries. The first major roof fall occurred on August 23, 1977 face advance 43m (142 ft). This fall extended .3m to 2.4m (1 to 8 ft) above



SHIELD TYPE SUPPORT
DEMONSTRATION
KAISER YORK CANYON MINE
RATON, NEW MEXICO
6TH NORTH PANEL

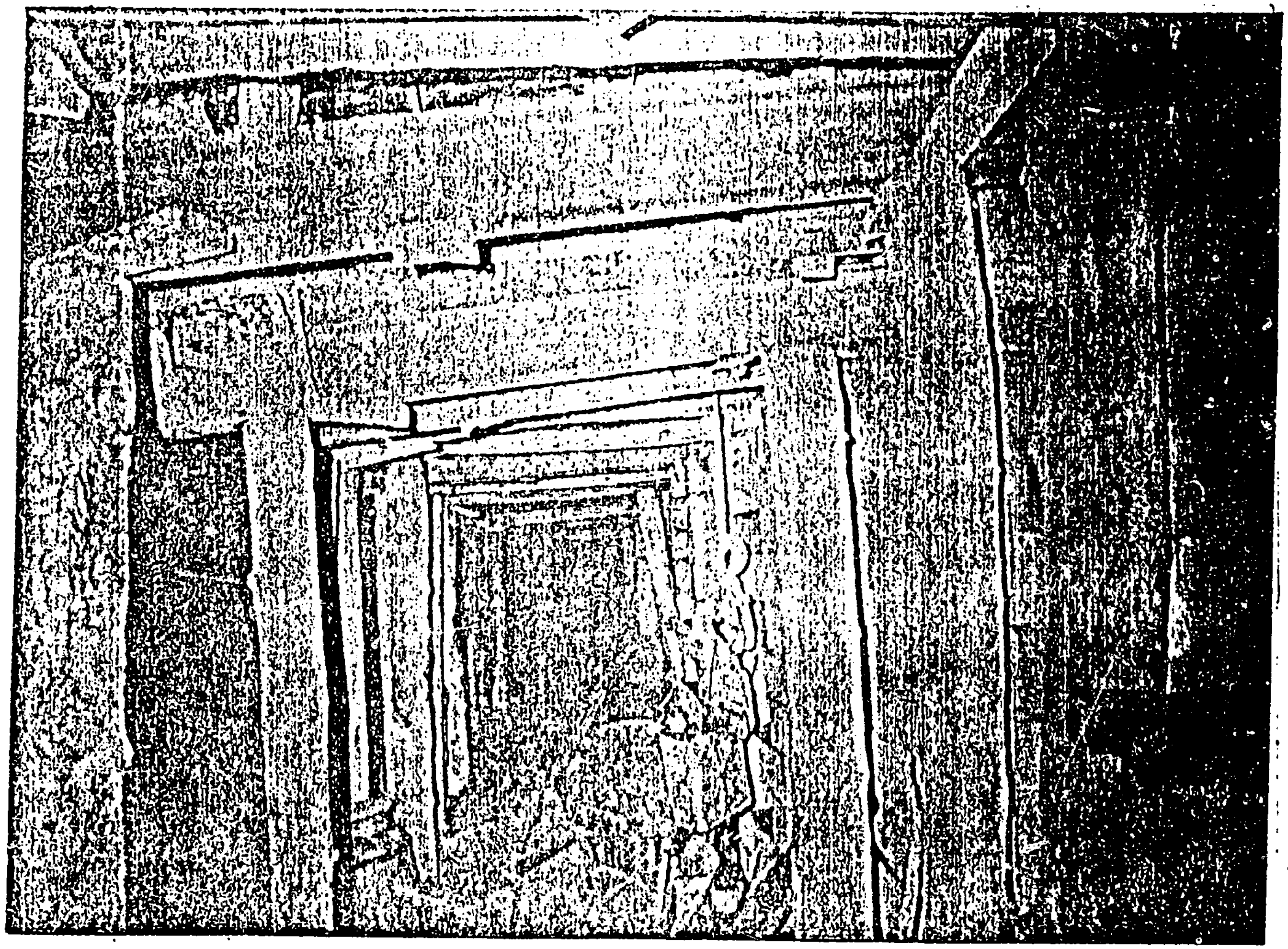
LOCATION OF MAJOR ROOF FALLS

FIGURE 19

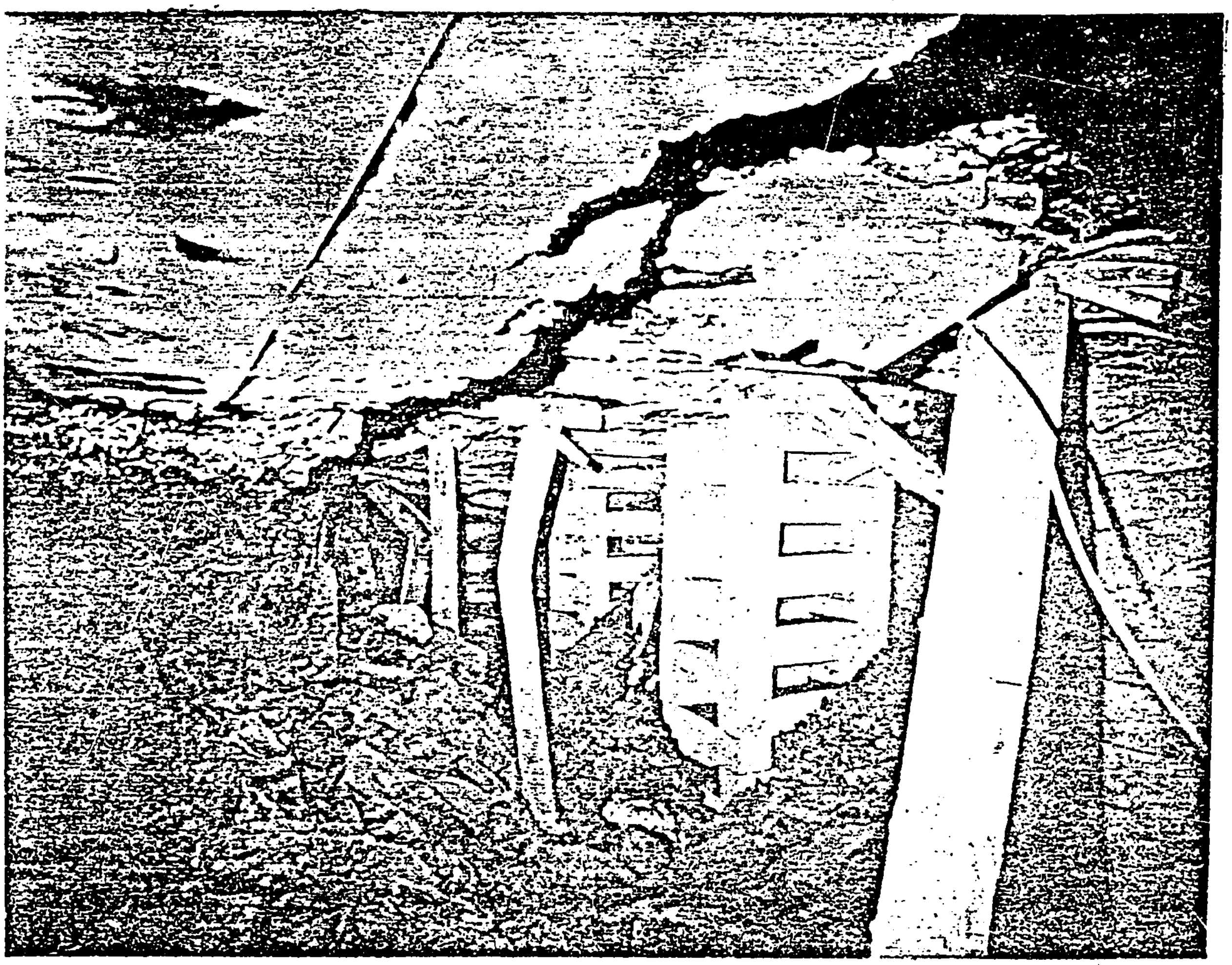


Photograph 5: Shale caprock falling out causing increased mining height on Panel 6-North

the shields and from shields 46 to 62. Before production could resume the fall area was secured with roof bolts. The rock which fell onto the conveyor had to be drilled and blasted. When it was small enough to handle, the rock was shoveled off the face conveyor into the travelway under the shields. Several production shifts were lost cleaning up and securing the fall. By September 1, 1977 face advance 56m (184 ft), the tailgate entry began deteriorating as a result of combined front and side abutment pressures. At this time the ribs began spalling and the floor started heaving up to 18m (60 ft) ahead of the face. To stabilize these problems, a single row of cribs was installed down the center of the entry ahead of the face. Photograph 6 shows the tailgate entry after the cribs were installed. Conditions in the tailgate continued to deteriorate and support in that area was increased. The entry was rebolted ahead of the face with 2.1m (7 ft) mechanical bolts. In addition to this, steel beams were installed on 1.2m (4 ft) centers and three rows of posts were set. On October 15, 1977, face advance 147m (482 ft), a major roof fall occurred in the tailgate. The roof in the tailgate came down on top of shields 104 and 105 causing these shields to become wedged between the roof and floor. Advancing these shields was very difficult and resulted in much delay time. At the same time, the roof in the tailgate ahead of the face continued to deteriorate with .3m to .9m (1 to 3 ft) high voids forming in the roof. In order to stabilize the tailgate, crews began resin grouting the roof strata ahead of the face an increasing the support with more steel beams, cribs and posts. Although conditions in the tailgate continued to be poor, resin grouting on a continuous basis for the remainder of the panel allowed operations to proceed in that area. Conditions in the tailgate commonly deteriorated up to 46m (150 ft) ahead of the face for the remainder of the panel. Major roof falls occurred along the face on November 9, 1977, face advance 187m (613 ft), and on November 16, 1977, face advance 197m (647 ft). The falls took place between shields 23 and 40 and shields 41 and 46. These falls extended above the rider seam and up to 1.8m (6 ft) into the main sandstone roof. Both falls resulted in the loss of several production shifts while the fall areas were bolted and the rock was drilled, blasted and cleaned off the conveyor. On December 6, 1977 face advance 218m (716 ft), the four month UMWA contract strike began. During the strike both the face and the tailgate stabilized and no significant deterioration was noted. In contrast to this, the tailgate of panel 6-Left and the bleeder entry between panel 6-Left and 6-North began very rapid and extreme deterioration. Photograph 7 shows this bleeder entry. Management employees were forced to secure the area with posts and cribs. The deteriorating conditions in this area may have been a result of overlapping pressure abutments between the two panels. At this time, panel 6-Left was approximately 152m (500 ft) behind panel 6-North. During the strike, the tailgate was resin grouted up to 61m (200 ft) ahead of the face. Much of the face was also grouted during this time. On March 27, 1978 the strike was over and operations continued. On March 29, 1978 face advance 223m (730 ft), a roof fall occurred between shields 40 and 45. This fall extended up to 1.5m (5 ft) into the overlying sandstone and was secured in the same manner as the previous falls.



Photograph 6: 6-North tailgate entry after extra posts, cribs, mats, and bolts were installed.



Photograph 7: Bleeder entry between 6-North and 6-Left

On April 12, 1978 face advance 237m (777 ft), steps were initiated to control the poor conditions at the face. To keep the face height within the operating limits of the shields, the face was cut no higher than 2.7m (9 ft). At this height, the shield canopies could remain within a couple of feet of the face at all times. Instead of trying to hold the shale caprock and rider seam, these units were cut in the normal cutting sequence with the shearer. The 2.7m (9 ft) operating height was maintained by leaving .6m to .9m (2 to 3 ft) of bottom coal. These changes resulted in an almost immediate improvement in conditions along most of the face and an increase in production. Although most of the face was now clear of poor conditions, two areas of very poor conditions persisted. These areas were a result of having to leave the caprock near the gate entries. When the gate entries were driven, up to .6m (2 ft) of cap coal was left as part of the roof. In order to maintain stable conditions and proper coal height in these entries, it was necessary to leave the rider seam and caprock adjacent to them. This resulted in roof transition areas with up to 1.2m (4 ft) difference in roof height. In these transition areas, the shields were extended to their maximums and the canopies were up to 1.5m (5 ft) away from the face. Difficulty in supporting these areas resulted in large piles of rock accumulating in the travelway and difficulty in advancing the shields. In order to maintain the caprock at the tailgate, the roof ahead of the shields was bolted and steel mats were installed after every shear. The caprock on the headgate side required intermittent bolting to remain stable.

By the end of May face advance 320m (1050 ft), panel 6-Left which started two months after and 252m (830 ft) behind panel 6-North was within 37m (120 ft). By this time the bleeder entry between the two panels and behind the 6-North face had become impassable. The bleeder entry which was originally supported with steel beams began taking weight ahead of the 6-North face. From this time on, support was continually increased in the headgate entries ahead of the face. Two rows of posts and a solid row of cribs were installed in the bleeder. On June 1, 1978 face advance 332m (1090 ft), the first roof fall occurred in the headgate. Another fall occurred five days later face advance 339m (1112 ft). These falls extended .6m to 1.2m (2 to 4 ft) high. In order to stabilize the headgate, additional cribs, posts and steel beams were installed in both the headgate and bleeder entries. Resin grouting and bolting ahead of the face at the headgate were also carried out on a regular basis. Advancing the shields through the poor conditions in the headgate was very slow and difficult. With all of the extra support, very little operating room was left. Realizing that the pressures from panel 6-Left were affecting panel 6-North, the 6-Left face was kept idle for four weeks in July. During this time the distance between the two faces was increased to 76m (250 ft). Conditions at the headgate continued to be very poor and competent roof was impossible to maintain. On August 9, 1978 face advance 428m (1405 ft), a major roof fall occurred in the transition zone on the headgate site. (Photograph 8) This fall was a result of the extremely slow face advance in an area where the shields could not adequately support the roof. The fall area was bolted and the broken rock was drilled, blasted and cleaned up as in previous falls. On September 3, 1978 face advance 444m (1458 ft), the largest and most difficult fall of the project occurred. This fall occurred between shields 17 and 27 and extended up to 6m (20 ft) above the shields. The roof in this area continued to fall with each shear until September 20, 1978 when a lip was finally established. First the roof ahead of the face was resin bolted and resin grouted in the area of the fall. Next 5cm (2 inch) holes were drilled horizontally into the face about 2.1m (7 ft) above the floor and 1.8m (6 ft) long. In each of these holes a 5cm (2 inch) OD and 3m (10 ft) long steel pipe was installed. The shields were lowered and placed under 1.2m (4 ft) of pipe that stuck out of the hole. Photograph 9 shows this fall with the pipes installed. Lagging was then placed on top of the pipes between the shields and random posts and crib blocks piled over these. This kept additional rocks from falling in at the face before the shields could advance under solid rock. With all of this additional support, the shearer was able to cut in the area of the fall without additional loss of roof rock. The shields were then able to advance under solid roof. On September 29, 1978 face advance 453m (1486 ft), conditions in the headgate deteriorated and the decision was made to abandon the 6-North face. The headgate entry squeezed until no more than three feet of working height remained at the face. (Photograph 10) This squeeze took place even though the headgate entry was supported with hydraulic jacks, posts, cribs and resin grout. At this point it was decided that Kaiser could no longer afford to fight poor conditions on panel 6-North and at the same time hold up production on panel 6-Left.

As with the other two panels, large lumps of coal were a problem on panel 6-North. These coal lumps and the constantly falling shale caprock slowed production considerably.

Approximately 244m (800 ft) from the panel starting position, a small fault appeared on the tailgate side of the panel. The maximum displacement of this fault was about .6m (2 ft). The shearer was able to cut its way through the fault and only minimal problems were encountered.

Face Operations

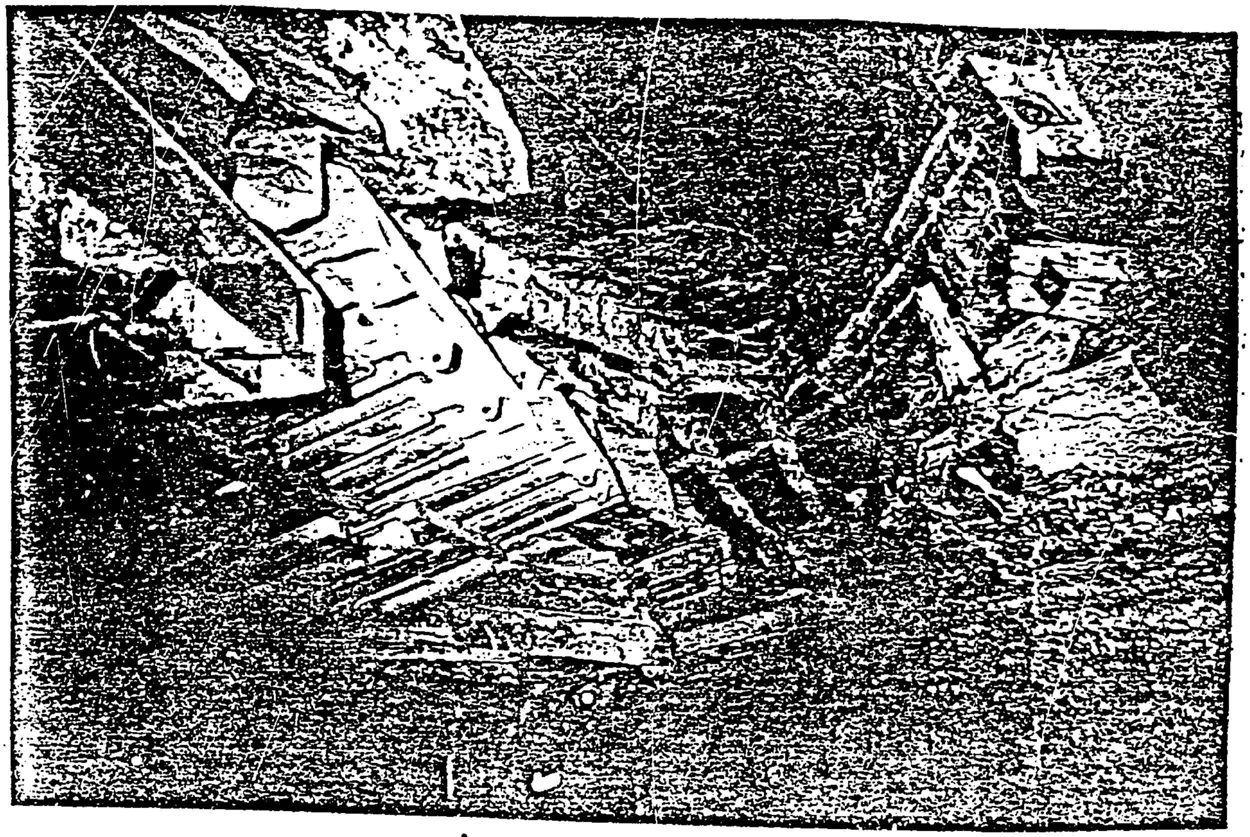
A variety of conditions were encountered during the three panel demonstration. To adjust to these changing conditions, face operations were modified or changed.

Method of Cutting and Shield Advance

Because of the changing conditions encountered, four methods of coal cutting and shield advance were used during the course of mining the three panels. These four methods are the one web back, European, half face, and one direction cutting systems.

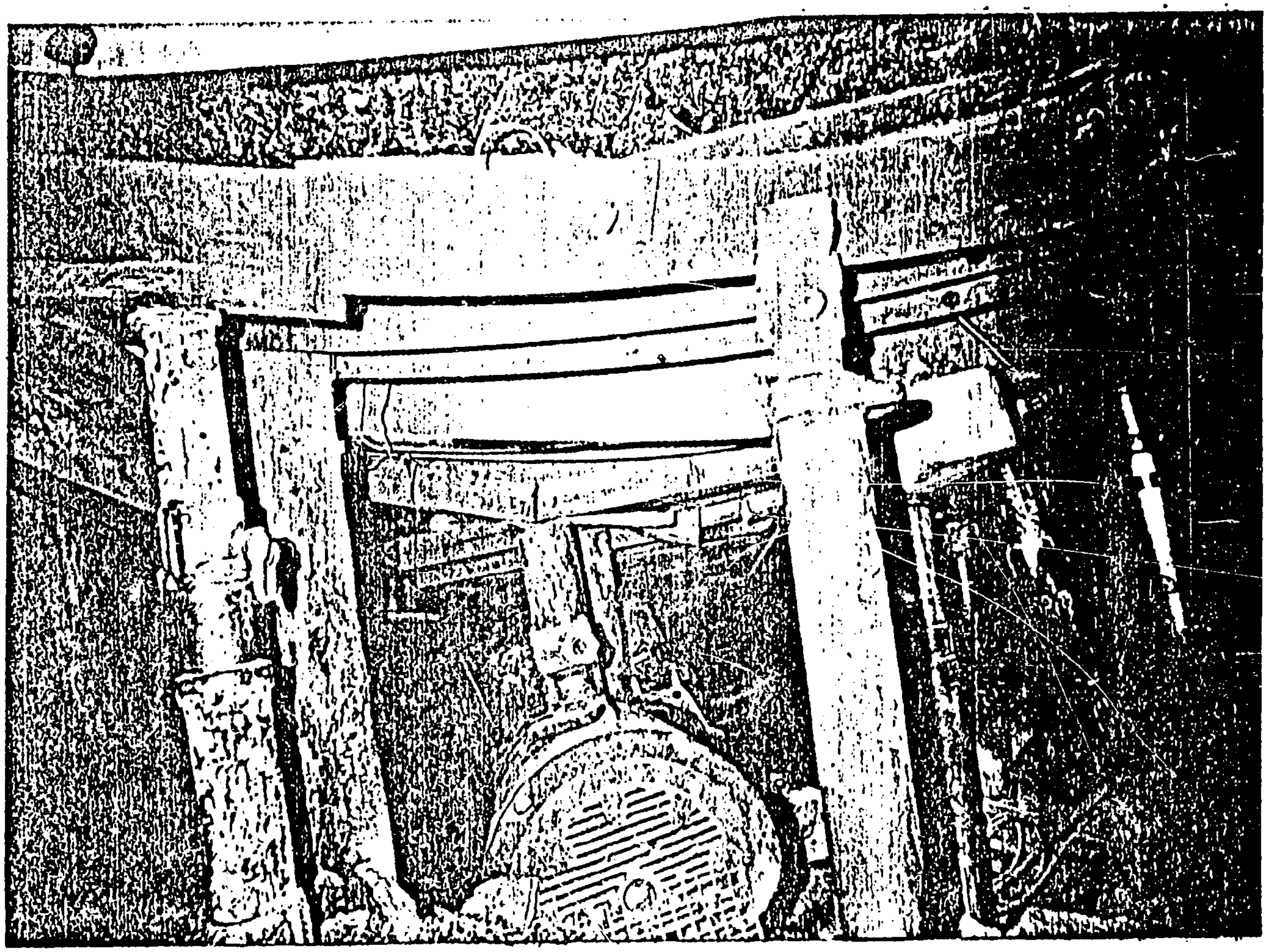
One Web Back System

The normal or one web back method of cutting coal was used at the



Photograph 8: Roof fall in tranzition zone in headgate area 8-9-78

Photograph 9: Roof fall showing 2" O.D. pipes installed to establish a lip. 9-17-78



Photograph 10: Headgate area on panel 6-North showing extreme pressures. 9-29-78

beginning of all three demonstration panels. If conditions permit its use, this method provides the greatest amount of working room and clearance under the shields. This results in easier and safer working conditions for the men. Using this method, the shearing machine sumps in at the headgate and cuts to the tailgate. It then sumps in at the tailgate and cuts to the headgate to complete the cycle. After the shearing machine has passed, the shields are brought to the forward position within 100 ft of the shearer. The face conveyor is then pushed forward. This mehtod results in all of the shields ahead of or more than 30m (100 ft) behind the shearing machine to be in the one web back position. The operation of the shearing machine is the same for the one web back and European system. Figure 22 illustrates these methods of coal cutting and face advance.

When using the one web back method, the travelway under the shields is less obstructed than with the other methods. All but about 20 shields are in the one web back position. Even though this method creates the best working environment, it can not be used in high seams with fragile or poor roof conditions. In the one web back position, the shields are further away from the face than in some other methods. This results in each shield having to support more roof area. In areas of poor or fragile roof, the roof has a tendency to fall between the end of the shield canopy and the face creating roof problems. This was clearly illustrated on panels 5-North and 6-North.

European System

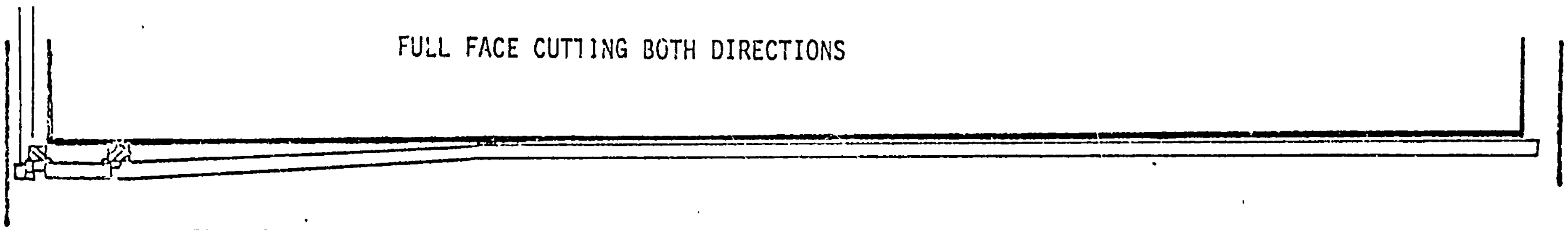
The European system of coal cutting and shield advance eliminates most of the problems encountered with the one web back method in high coal seams and poor roof conditions. With this method, the shields are kept tight against the face conveyor at all times. Photograph 11 shows the shields tight against the face conveyor. The shearing machine cuts in the same manner as the one web back method. After the shearing machine has passed, the face conveyor is pushed forward leaving approximately 23m (75 ft) to the shearer. After the conveyor has been pushed forward, the shields are brought in tight against the face conveyor.

Because the shields are tight against the face conveyor at all times, the European method of operation results in a much more restricted travelway and poorer working conditions. These poorer working conditions become necessary when weighed against the better roof control gained by having the shields in the forward position. With the shields tight against the face conveyor, greater roof resistance is obtained and there is little or no unsupported roof ahead of the shields. This method was used for most of panel 6-North.

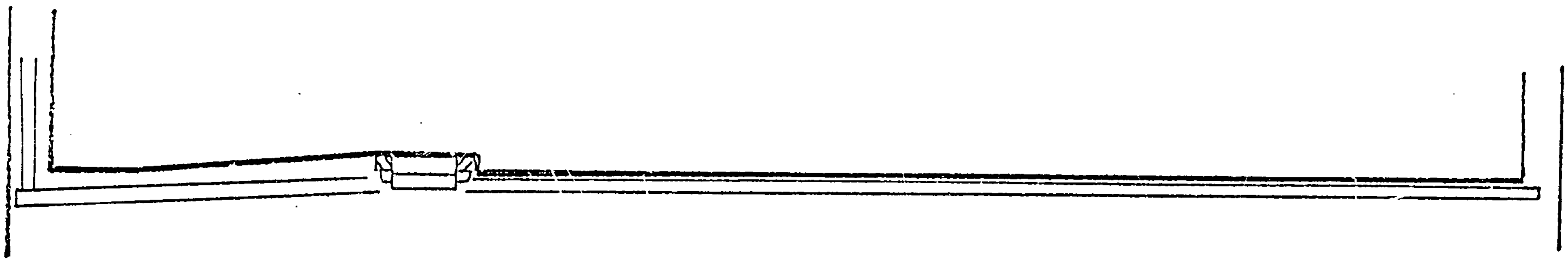
Half Face System

The half face system was tried on panel 4-North to try and remedy the accumulation of large coal lumps in front of the shearing machine when it cut to the tailgate. This method was abandoned after a short time because it only cut the lump problem in half.

FULL FACE CUTTING BOTH DIRECTIONS



Shearing machine is ready to begin cycle. The face conveyor is pushed over for the sump.

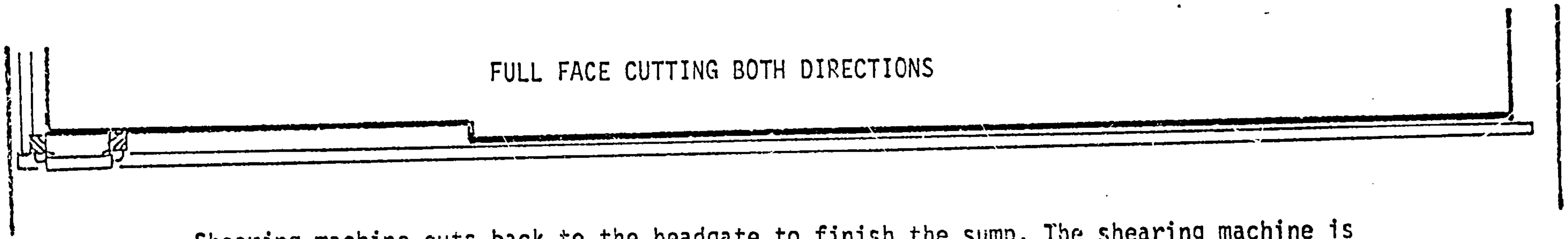


Shearing machine sumps in and the face conveyor will now be pushed over at the headgate so that the shearing machine can finish the sump.

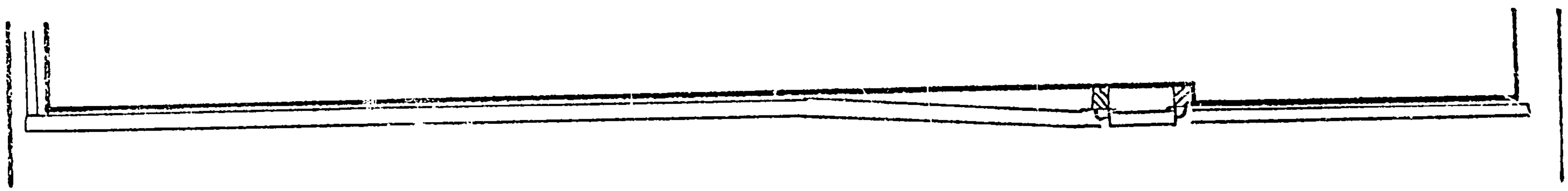
FIGURE 20A

Drawing not to scale

FULL FACE CUTTING BOTH DIRECTIONS



Shearing machine cuts back to the headgate to finish the sump. The shearing machine is now ready to cut coal toward the tailgate entry.

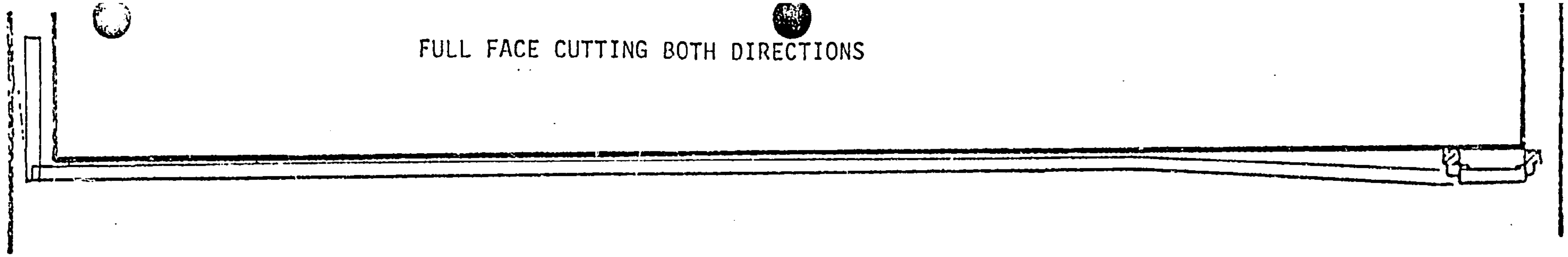


Shearing machine cuts to the tailgate entry. The face conveyor is pushed over after the shearing machine has passed.

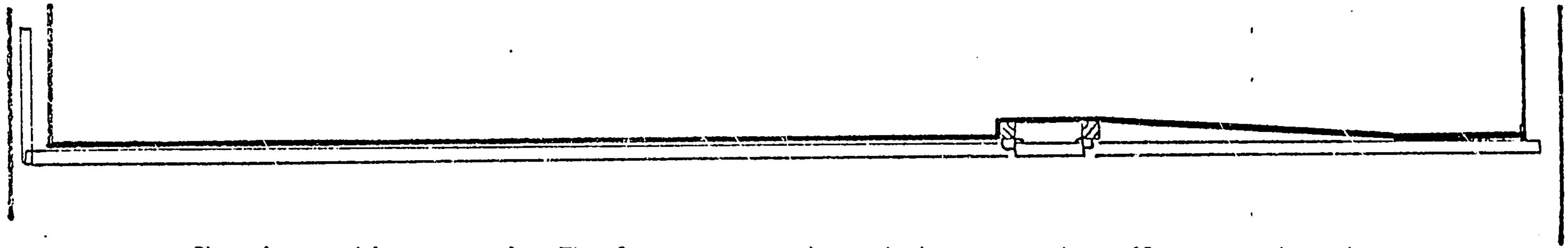
FIGURE 20B

Drawing not to scale

FULL FACE CUTTING BOTH DIRECTIONS



Shearing machine breaks through the tailgate. The face conveyor is pushed forward to prepare for the sump at the tailgate.

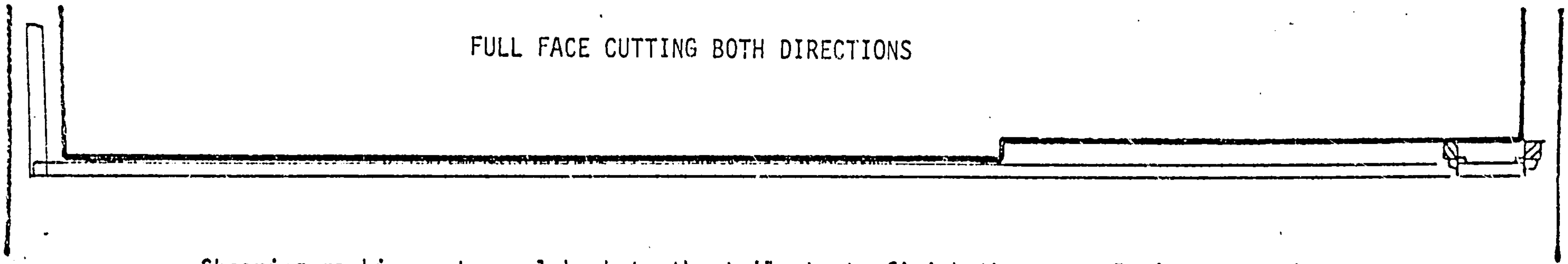


Shearing machine sumps in. The face conveyor is pushed over at the tailgate so that the shearing machine can cut to the tailgate.

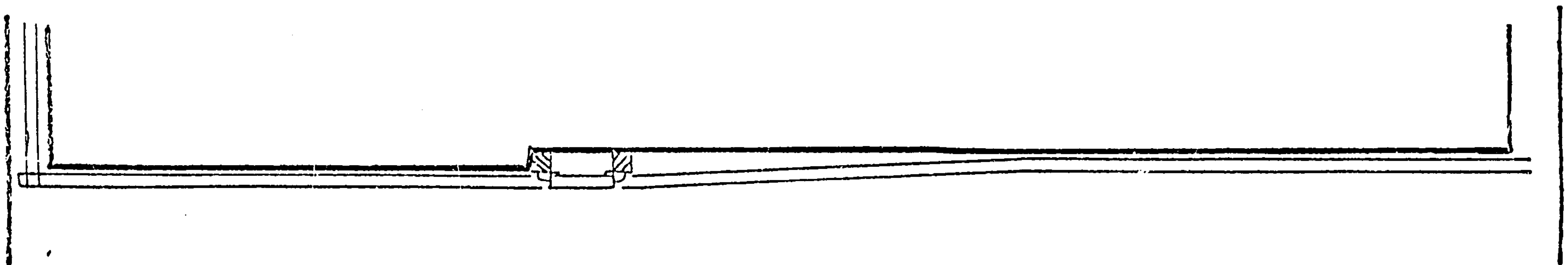
FIGURE 20C

Drawing not to scale

FULL FACE CUTTING BOTH DIRECTIONS



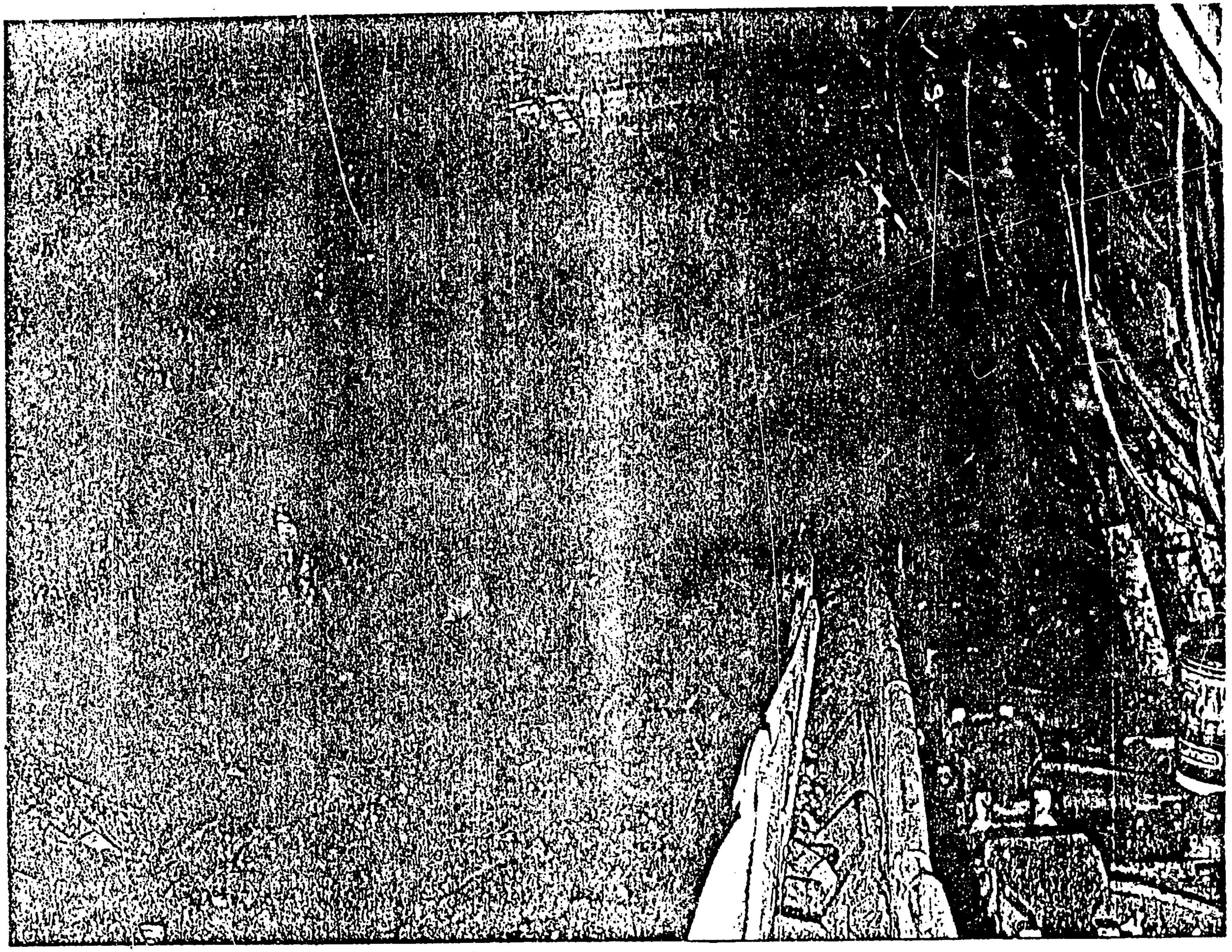
Shearing machine cuts coal back to the tailgate to finish the sump. It is now ready to cut coal toward the headgate entry.



Shearing machine cuts to the headgate entry. The face conveyor is pushed forward behind the shearing machine to prepare for the next cycle.

FIGURE 20D

Drawing not to scale



Photograph 11: Shields tight against face conveyor with European system

With the half face method, the shearing machine travels from the headgate to the center of the panel and then cuts to the tailgate. It then travels back to the center of the face and cuts to the headgate to complete the cycle. After the shearing machine passes, the shields which were originally in the one web back position are brought in tight against the face conveyor. The face conveyor must be left back from the face until the shearer returns to the center of the panel. This is necessary since the shearer cannot travel along the face with the conveyor pushed forward without cutting coal. When the face conveyor is pushed forward, the shields are left in the one web back position. When this method is used, half of the shields are tight against the face conveyor and half are in the one web back position at all times. The distance from the shield canopies to the face is the same as if all shields were in the one web back position. Figure 21 illustrates the half face method.

Because half of the shields are tight against the face conveyor at all times this method results in poorer working conditions for half of the face. This method is also limited to areas with good roof since all the shields are never tight against the face.

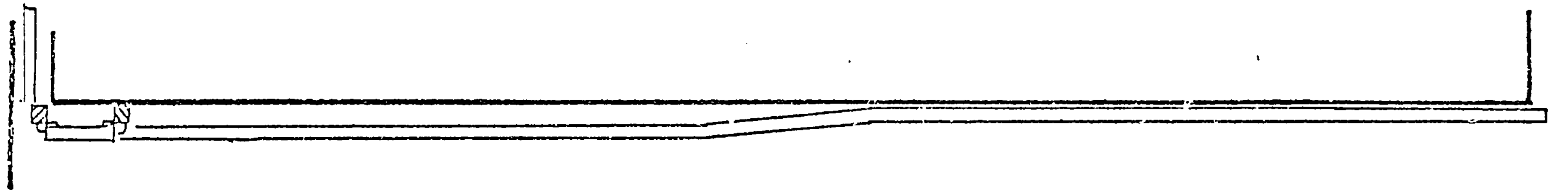
One Direction System

One direction cutting was adopted on panels 4-North and 5-North to eliminate lumps from building up in front of the shearer as it cut to the tailgate. With this method, the coal was cut from the tailgate to the headgate. After the shearer passed the canopies were extended to support the roof. The shearer would then travel back to the tailgate. The conveyor was then advanced and the shields were brought in. It should be noted that in this method, the shields could be left in the one web back or European fashion depending on the roof conditions. Although the problem of lumps building up in front of the shearer was solved with this method, lumps still caused problems at the headgate. Figure 22 illustrates the one direction system of cutting coal.

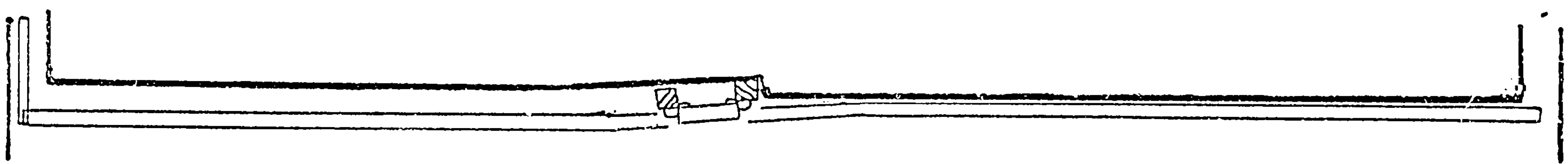
Face Conveyor Operations

Conveyor hang-ups resulted in much down time on all three demonstration panels. The accumulation of fine coal under the conveyor combined with overloading caused the conveyor to become hung-up. Heaving floor at the face may also have contributed to this problem. When the conveyor became stuck it was often necessary to shovel it clean, raise it, and block it up to free the conveyor flights. This process was often very time consuming. In addition, shoveling the coal off the conveyor created piles of rock and coal in the travelway under the shields. This resulted in poor working conditions and difficulty in advancing the shields. It also resulted in many hoses being broken by the loose rock as the shields were advanced. To keep the conveyor from hanging up, it was necessary for the headgate man to continually monitor the motor amp meter guages. When the motors would begin to pull 100 amps or more, the shearing machine was shut down until the conveyor cleared.

HALF-FACE METHOD



Shearing machine is ready to start cycle. The face conveyor is away from the face for the first half of the face and is pushed against the face on the last half of the face.

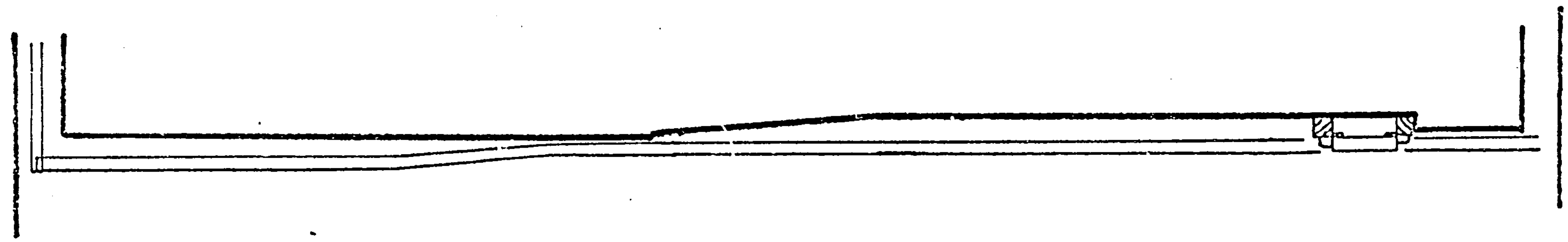


The shearing machine flits to the center of the face without cutting coal. the shearing machine is then sumped in at the center of the face. It is then ready to cut coal toward the tailgate.

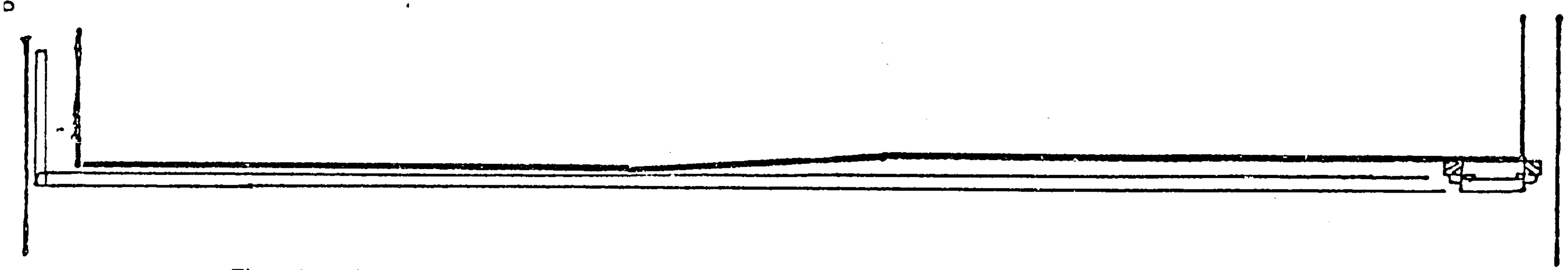
FIGURE 21A

Drawing not to scale

HALF-FACE METHOD



The shearing machine cuts toward the tailgate. The face conveyor is pushed forward from the center of the face to the headgate to prepare for the return cut.

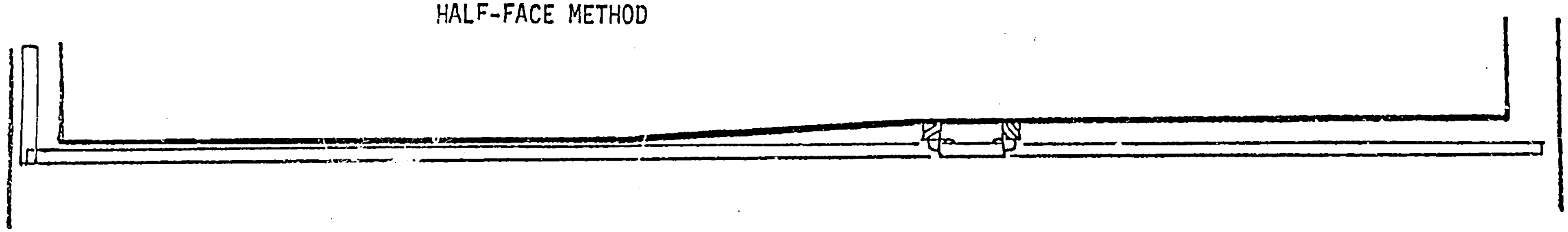


The shearing machine breaks through the tailgateand flips the cowls. The face conveyor has been pushed over on the first half of the face for the return cut. The shearing machine will now flit to the center of the face without cutting coal.

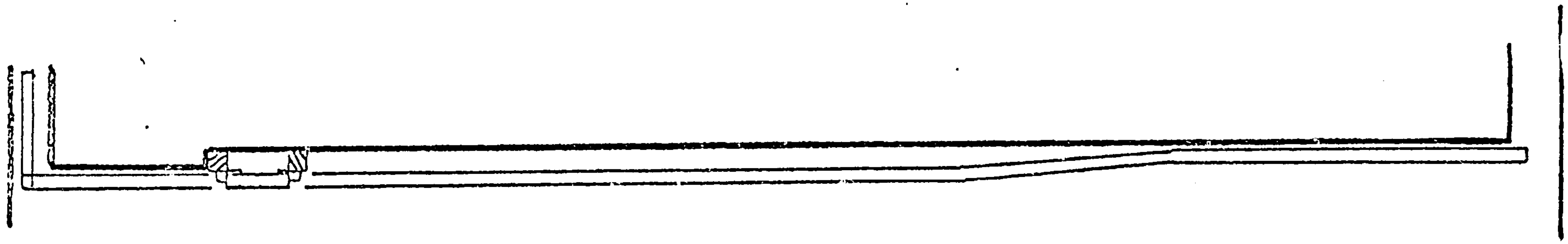
FIGURE 21B

Drawing not to scale

HALF-FACE METHOD



The shearing machine flits to the center of the face.

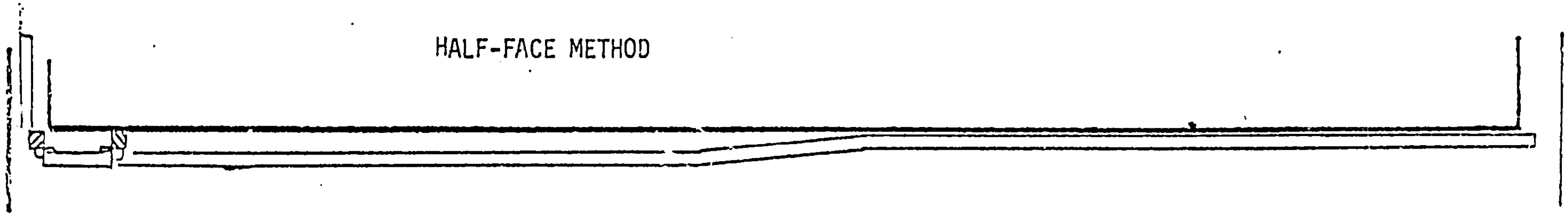


The shearing machine cuts coal from the center of the face towards the headgate. The face conveyor is pushed over from the tailgate to the center of the face to prepare for the next cycle.

FIGURE 21C

Drawing not to scale

HALF-FACE METHOD

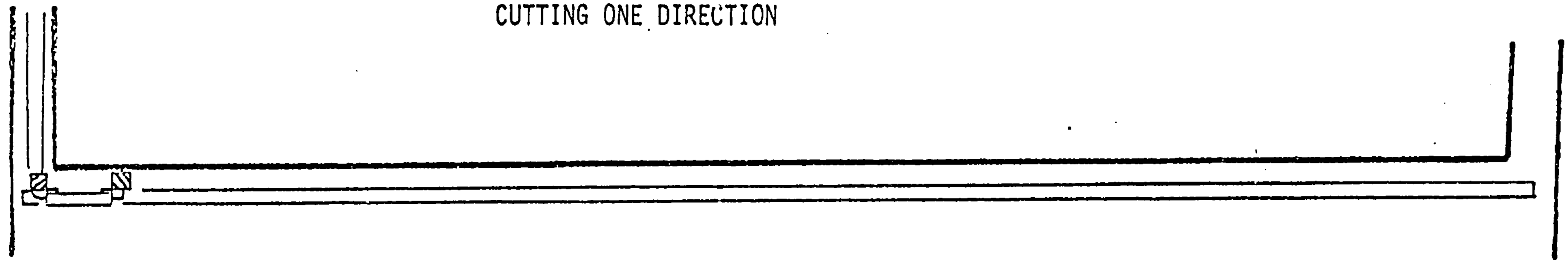


The cycle is completed when the shearing machine breaks through to the headgate entry. The face conveyor has been pushed over on the tailgate half of the face so that the next cycle is ready to start.

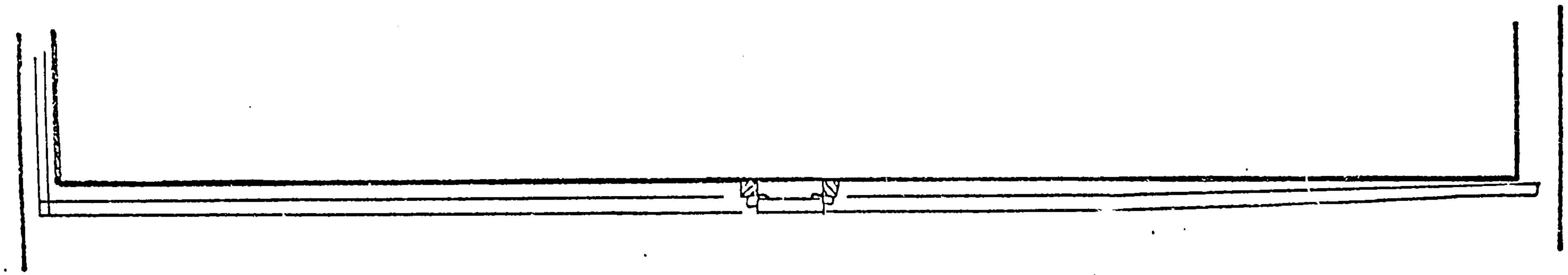
FIGURE 21D

Drawing not to scale

CUTTING ONE DIRECTION



Shearing machine is ready to start cycle. Machine will flit to the tailgate entry without cutting. Face conveyor is back to allow shearing machine to pass without cutting coal.

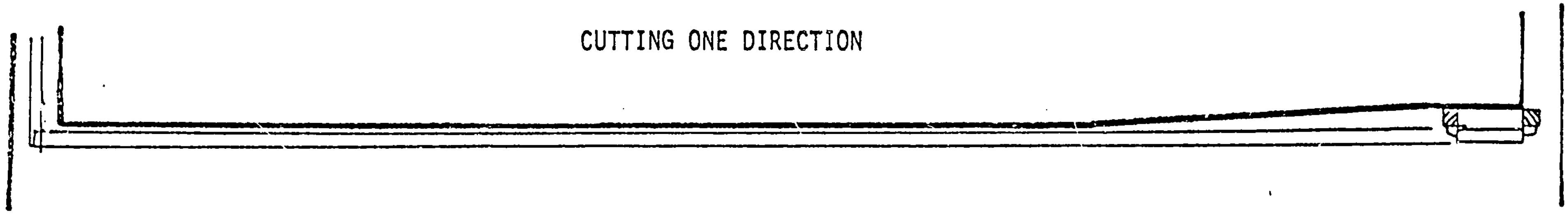


Shearing machine flits to the tailgate entry without cutting coal. The face conveyor is pushed over at the tailgate for the sump.

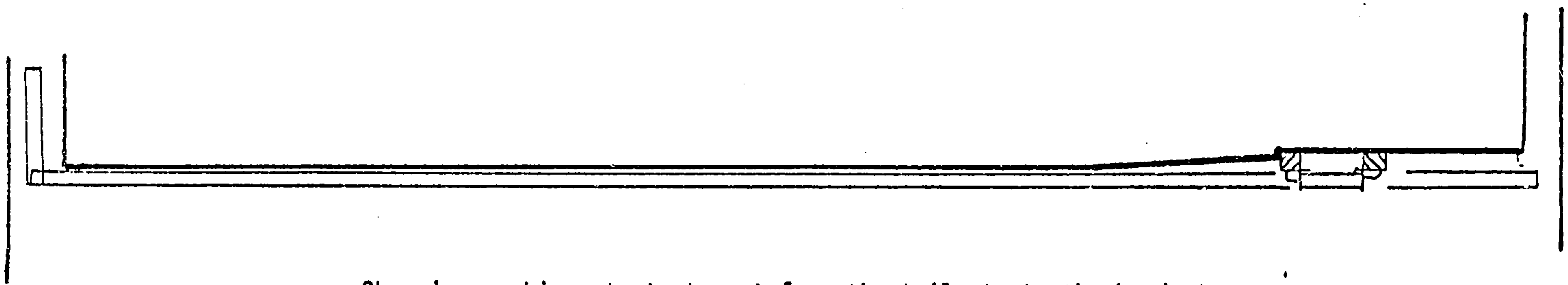
FIGURE 22A

Drawing not to scale

CUTTING ONE DIRECTION



Shearing machine is sumped in at the tailgate. The face conveyor is pushed over across the face so that the shearing machine can cut coal on the way from the tailgate to the headgate.

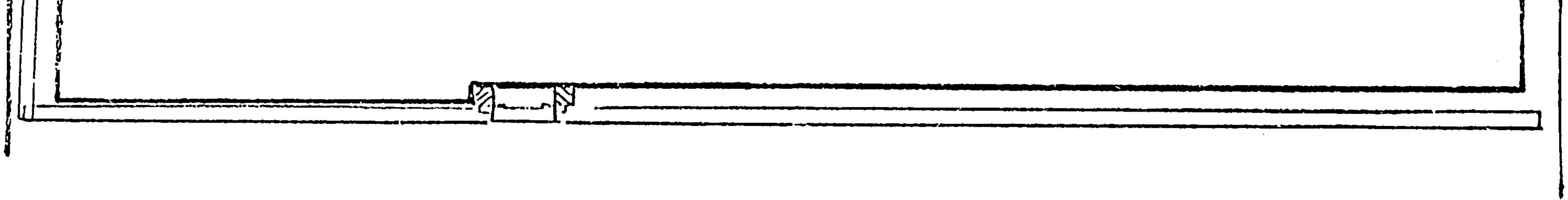


Shearing machine starts to cut from the tailgate to the headgate.

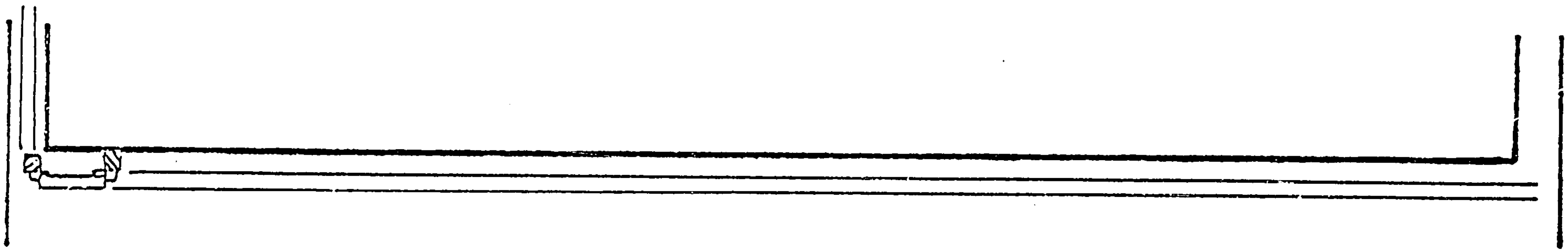
FIGURE 22B

Drawing not to scale

CUTTING ONE DIRECTION



Shearing machine continues cutting coal from the tailgate to the headgate. The face conveyor is left back so that the shearing machine can flit to the tailgate on the next cycle.



Shearing machine breaks through the headgate. It is now ready to start the cycle over again.

FIGURE 22C

Drawing not to scale

Large lumps of coal and shale also prevented proper conveyor operations. These large lumps accumulated at the face conveyor discharge point restricting the flow of coal to the stage loader. This problem resulted in hiring an extra man to break the large lumps with a jackhammer or sledge hammer as they accumulated. Even with this extra man, it was often necessary to shut the conveyor off while the lumps were being broken. (Photograph 12)

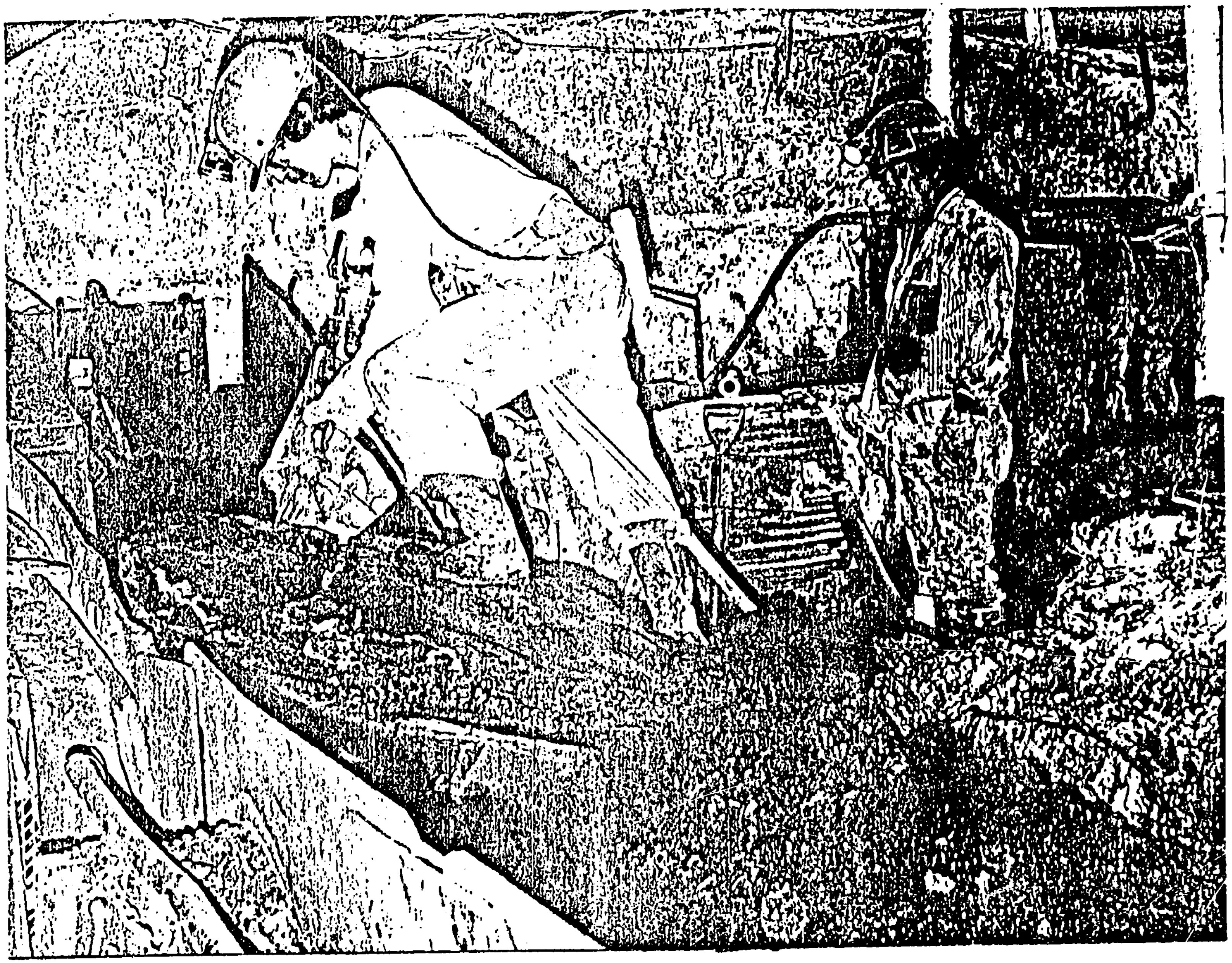
Panel Completion and Moves

One major area of concern in the planning stage of shield longwalls has been the moving of the equipment to the following longwall panel, and in particular, the recovery of the shield supports (Linden, 1977, p. 160). The most critical aspect of recovering shield supports is that caved gob material covers the gob shield. Upon removing a shield, this material could easily flush into the face if protective measures were not taken (Linden, 1977, p. 160).

Panel 4-North

Approximately 9m (30 ft) before the end of panel 4-North, wire mesh and small I-beams were placed over the shields. As the shields advanced the last 9m (30 ft), this operation continued. The object of the wire mesh was to form a continuous layer over the shield canopies and the gob shields to prevent gob flushing (Linden, 1977, p. 161). After the last cut, the face conveyor was unhooked from the shields. The face conveyor, shearer and auxilary equipment were removed from the face with a winch which was installed at the headgate. When this was done, the roof in front of the shields was bolted using a Fletcher narrow bolter especially designed to fit between the shields and the face. For additional support, wooden planks were placed over each shield and supported at the face with a post. Forty pound rail was laid on the floor so that the shields would slide more easily when being removed. Starting at the tailgate, each shield was pulled forward, turned so it faced the tailgate, and then pulled to the headgate with the winch. At the headgate it was loaded onto a low boy trailer and transported to the next panel with a battery scoop tram. As each shield was removed, a timber crib was set in its place to prevent sagging of the wire and flushing of gob. Hydraulic props and posts were also used to help support the wire mesh during this operation. This process continued until all the shields were removed from the face.

Each piece of equipment removed from panel 4-North was ta[illegible] immediately to panel 5-North with the exception of the shearer. As the eq[illegible]nt arrived at panel 5-North, it was reconstructed and set into place. Any maintenance work that needed to be done was also taken care of at this time. Panel 5-North began operations 42 working days after the completion of panel 4-North.



Photograph 12; Extra man used to break coal lumps with air pick at headgate

Panel 5-North

Upon completion of panel 5-North, the face area was supported in the same manner as the 4-North face. Wire mesh, I-beams, roof bolts, wooden planks and posts were used to secure the face area. The forty pound rails were not used in this move because the floor was strong enough to support the moving operations without deteriorating. The major change in the moving process involved the utilization of trailing shields. For this move, the last two shields at the tailgate were turned 90° so they were parallel with the coal face. Photograph 13 shows these trailing shields. As each shield was removed from the face, these trailing shields were advanced forward towards the headgate. This provided support in the shield removal area and allowed safer installation of the cribs and posts after a shield had been removed. A plan view of the recovery operation for panel 5-North is shown in figure 23.

The equipment was transported to panel 6-North in the same manner as the previous move. During this move the shields were adjusted for the lower expected seam height. The face guards and side shields were removed and the foam rubber canopy cushions were installed. At the same time the lights were relocated and the shields were hosed for adjacent control. Panel 6-North began operations 45 working days after the completion of panel 4-North.

Panel 6-North

Panel 6-North was terminated early because of the poor roof conditions on the panel. A roof fall in the headgate area made it impossible for a normal recovery of the shields. The roof over the shields was not possible to secure with wire mesh and I beams because of the quick decision to terminate the panel.

Access was cut off to the headgate entry because of the roof fall. Therefore two entries had to be driven through the remaining 1150 feet of the panel to establish a new headgate entry at shield #30. The new headgate entry was parallel to and 150 feet from the old headgate entry. This entry was supported with yieldable steel arches as it approached the face.

Another entry was then driven toward the old headgate entry 80 feet from the face. This entry was also supported with yieldable steel arches. This entry was stopped approximately 10 feet from the old headgate entry to avoid roof and ventilation problems. One access entry was then driven off of this entry and intersected the longwall face. This entry was parallel to and 10 feet from the original headgate entry. This entry was supported with yieldable steel arches as were the other entries. Figure 24 shows a plan view of these entries.

Holes from 4 to 10 feet in length were drilled in the first 150 feet of the face and urethane resin was injected to stabilize the face and roof. Starting with shield #30 and progressing toward the headgate, shields #30-#6 were extracted and hauled through the new access entry. As each shield was removed, a crib was built in its place for roof support and prevention of gob flushing. The shields were pulled into the entry by the use of a hydraulic winch installed in the access entry.

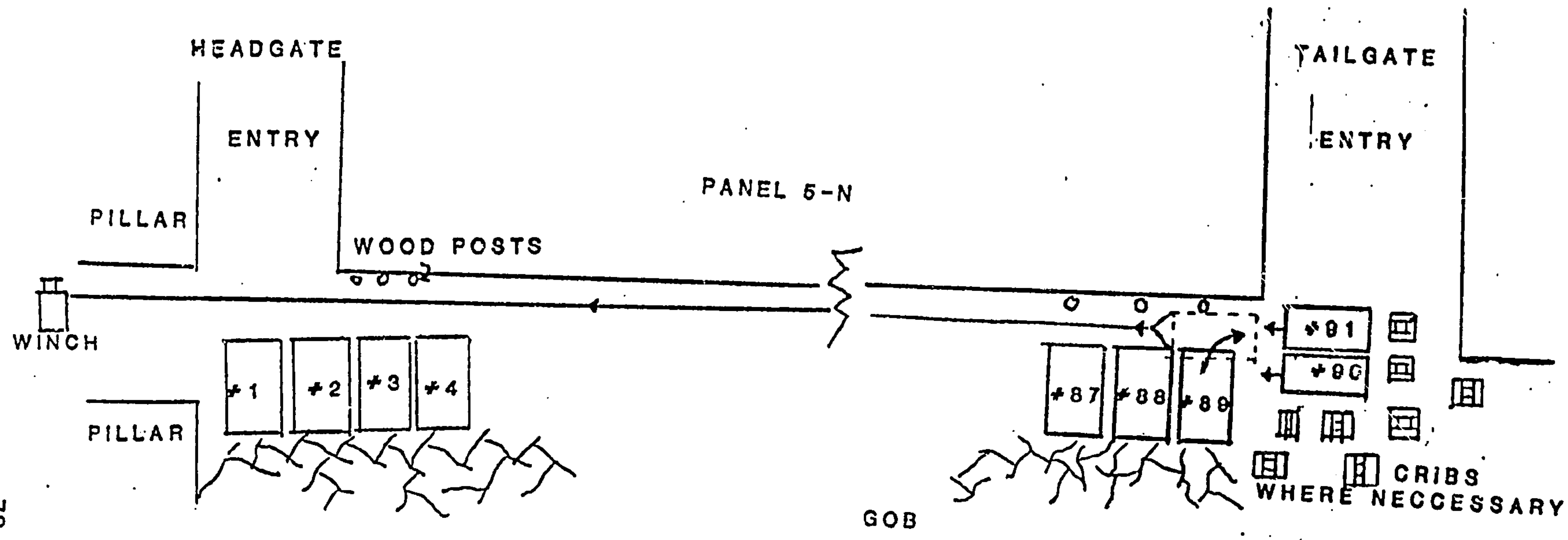
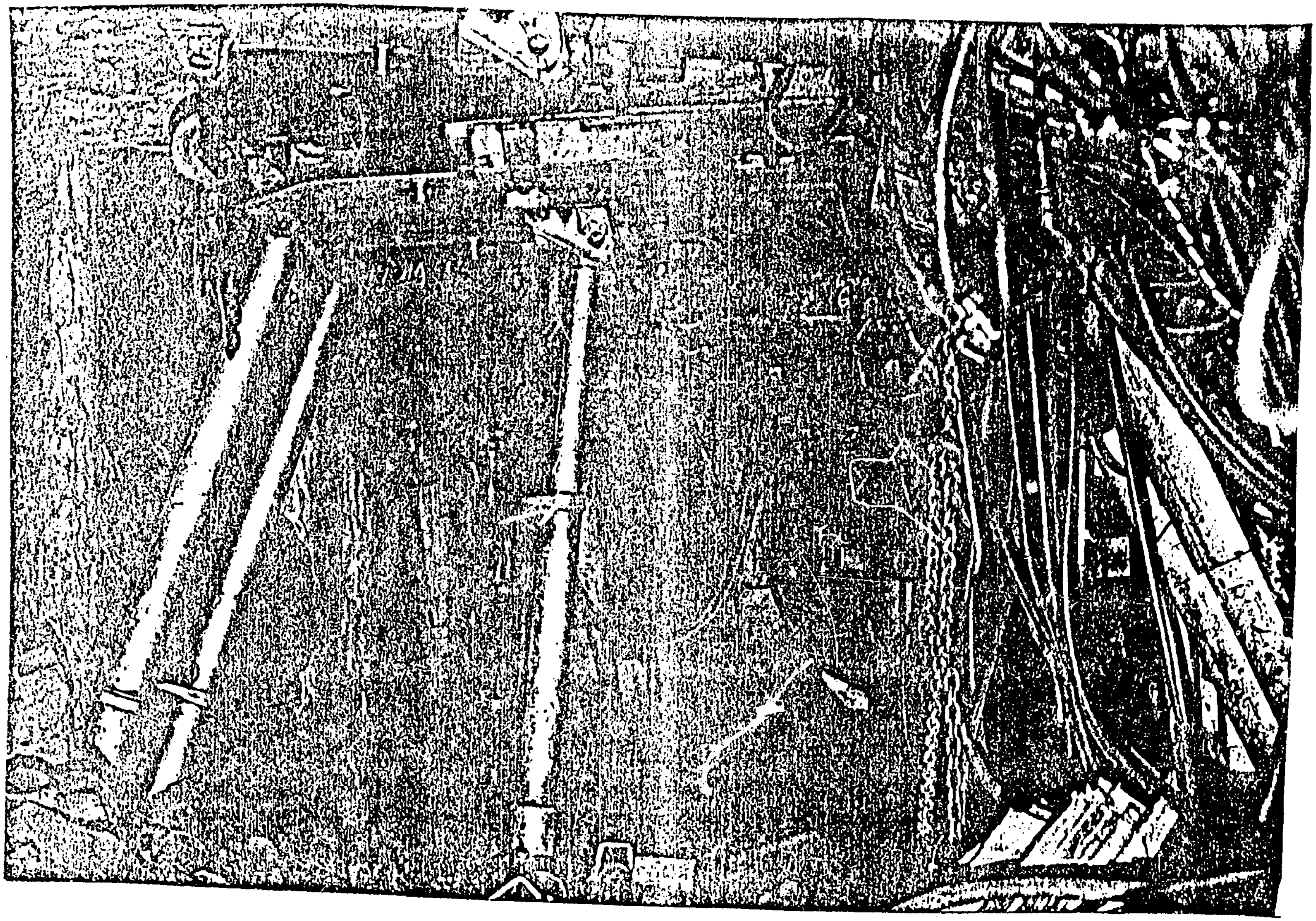


Figure 23 Panel 5-N Shield Removal Plan



Photograph 13; Move from 5-North to 6-North utilizing trailing shields

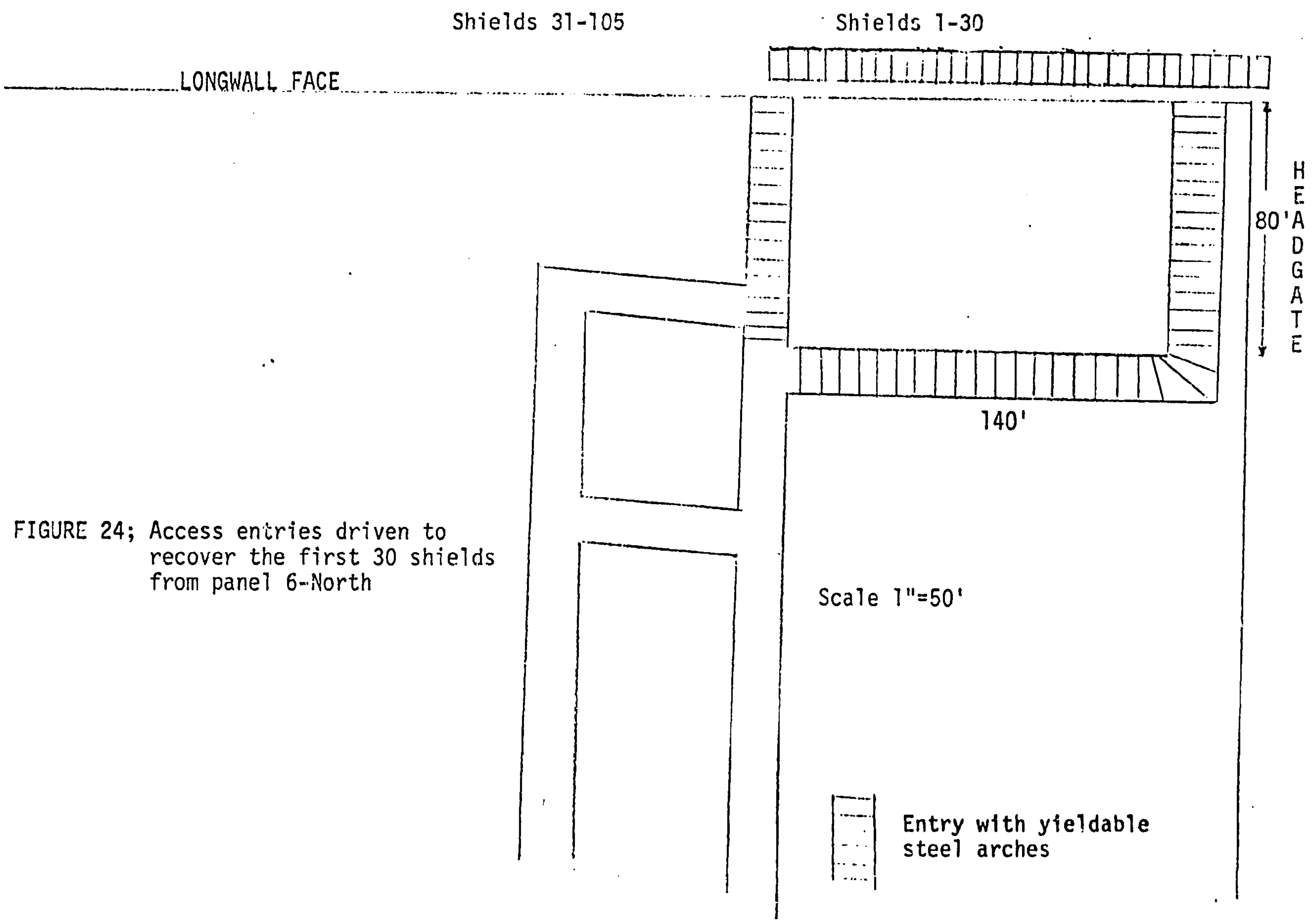


FIGURE 24; Access entries driven to recover the first 30 shields from panel 6-North

The first 5 shields were removed in the same manner as were #30-#6. Starting at the first shield and working toward shield #5, they were removed through the new access entry. As they were removed, cribs were built in their place for roof support. The first 3 shields were under badly broken roof but presented little problem being removed. The reason for this was two fold. First of all, the 6-Left panel had advanced over 1,000 feet past this point, which relieved the majority of the pressure. Secondly, the broken roof was stabilized with resin injection. The first 30 shields were removed aproximately 5 months after the longwall was terminated.

In order to recover shields #31-105, a continuous miner was brought in to make one pass across the face 8 feet wide. The roof was bolted and the remaining 75 shields were removed in the same manner as the others.

Working Conditions

Although the same basic equipment was used for all three demonstration panels, the working conditions on panels 4-North and 5-North were much better than the conditions on panel 6-North. The large differences were a result of poorer roof conditions on panel 6-North coupled with operating constraints of the shields.

Lighting

Face lighting was purchased by the Government and installed by Kaiser personnel with the help of the Government. The Ocean Energy fluorescent luminaires were enclosed in a protective cover and were intrinsically safe. Fifteen power sources output 12 volts AC from an input power of 120 volts AC. Each of these power sources powered eight 20 watt lights.

For panels 4-North and 5-North the lights were mounted on the inside of the left side shield extension perpendicular to the face. On panel 6 North the lights were mounted parallel to the face under and to the rear of the roof canopy. In this position the lights were vulnerable to falling rock and proved unsatisfactory in poor roof conditions. Because so many of the lights were broken on panel 6-North, face lighting was discontinued on that panel.

When the lights were working, the faces were very well lighted. Lighting definitely improved the working environment and miner attitudes were supportive of the lights. The face lighting was particularly helpful in keeping the face conveyor in alignment. The accident frequency or severity rate did not seem to be affected by the presence of lighting. Even though safety records showed no positive effects from the lighting, the better working environment is conducive to safer operation.

Federal law requires .06 foot Lamberts (ftL) illumination on the face and travelway. A survey was conducted by the Government on August 4, 1976 on the 4-North panel. The following measurements were obtained on the face beginning at the intersection of the face and floor, proceeding upward in two-foot increments toward the 10-foot high roof:

0 ft.	.06 ftL	2.25 ftC
2 ft.	.06 ftL	2.0 ftC
4 ft.	.045 ftL	1.5 ftC
6 ft.	.035 ftL	1.0 ftC
8 ft.	7.02 ftL	7.1 ftC
10 ft.	7.02 ftL	7.1 ftC

The floor was found to be illuminated to an average of .04 ftL; the travelway .09 ftL.

The luminaires were temporarily mounted horizontally at the junction of the canopy and the main frame of three shields. The following measurements were obtained in this area at the face, beginning at the intersection of the floor and face and proceeding upward toward the roof:

0 ft.	.09 ftL	4.0 ftC
2 ft.	.11 ftL	4.2 ftC
4 ft.	.11 ftL	4.5 ftC
6 ft.	.18 ftL	4.6 ftC
8 ft.	.14 ftL	4.4 ftC
10 ft.	.10 ftL	4.0 ftC

The floor, beginning at the face and proceeding in two-foot increments toward the spill pan:

0 ft.	.09 ftL	4.0 ftC
2 ft.	.08 ftL	4.25 ftC
4 ft.	.2 ftL	5.0 ftC
6 ft.	.3 ftL	5.0 ftC

The travelway was illuminated to an average of .085 ftL, 3.2 ftC. The lights were not mounted horizontally because of their vulnerability to rocks. The lights were within acceptable limits in all measurements except the 4-6 foot heights.

Many problems were experienced in operating the lights. The power supplies which were mounted on the shield bases proved to be very high maintainance items. These power supplies continually malfunctioned. Printed circuit boards and fuses were responsible for these problems. The luminaires themselves proved to be dependable except in poor roof conditions where they were vulnerable to breakage. The original connection plugs proved to be unsatisfactory and had to be replaced with a cannon type connector. Because of the high maintainance cost and time spent installing, moving, and repairing the system, the lighting system was considered to be a liability rather than an asset.

Dust and Ventilation

According to the Health and Safety Act of 1969, the respirable dust level in an underground working place must not exceed 2 milligrams per cubic meter for an 8 hour period. Very few if any longwalls in the United States have been able to consistently stay in compliance with this regulation.

Statistical analysis of the dust samples taken on the chock and shield faces at York Canyon show the shield faces have a higher average concentration of dust than the chock faces. This is primarily due to the higher production achieved on the shield longwall faces. The higher seam heights mined by the shield longwalls may also be responsible for the greater dust concentrations. With higher seam heights, more surface area is exposed from which dust can be picked up. Appendix 2 shows that panel 5-North had the highest average dust concentrations of any of the longwalls. This resulted from higher production on this panel than on the other two demonstration panels.

Appendix 2 is a list of dust samples taken by Kaiser Steel personnel. These samples are sent to the Government for analysis and subsequently a notice of compliance or non-compliance. Reasons for void samples include insufficient production (less than half the average section production), no date, no social security number, and over sized particles. The sections with the highest production has the highest concentration of respirable dust. Conversely, the sections with the lowest production has lower respirable dust concentrations. Panel 6-North had a lower seam height which increased the velocity of the air and decreased the surface area available for dust to be picked up from. Poor roof conditions tend to increase the dust from the shield canopies but is more than offset by the lower production caused by poor roof conditions.

The high risk operations are the operations in which the men are outby the shearing machine. These include the tailgate man and the shearer operators. There are respirators and airstream helmets available for these men which filter the air which the men breath but do nothing for the surrounding environment.

Because a shield face is completely enclosed, ventilation is much easier. A smaller percentage of air is lost to the gob with this system of mining. Ventilation of the longwall panels was accomplished by intaking air at the headgate, across the face, and returning the air out the tailgate. A minimum of 30,000 CFM of air was maintained at the last open breakthrough in the headgate entry. This was necessary to maintain 15,000 CFM on the return side of the panel. This represents a 50 percent loss of air to the gob, headgate, and belt entries.

Travelways and Clearance

The shield longwall face proved to be fully satisfactory on panels 4-North and 5-North. On these panels the travelways remained unobstructed. Because of the high seam height and proper adjustment of the shields, there was more than adequate operating room and clearance under the shields. Conditions on panel 6-North were not so satisfactory. Because of the continuous poor roof conditions and conveyor hangups, the travelway under the shields was very often obstructed with piles of broken rock. This resulted in unsure footing and unsafe conditions. In order to control the poor roof conditions the shields were kept up tight against the face conveyor. This made access under the shields very difficult. On several occasions the men had to traverse the face on the face conveyor in order to get from one end to the other. Had the shields been adjusted for the proper seam height, the clearance would probably have been much better.

EVALUATION OF SHIELD PERFORMANCE

Throughout the demonstration panel project, data was collected for evaluating the performance of shield type longwall supports. Safety, maintenance, production, roof control, and worker attitudes were investigated in this evaluation.

Safety

Safety is one of the most important operational considerations that must be addressed when evaluating the performance of a mining system. Longwall mining has proven to be one of the safest mining methods for producing underground coal. Shield type supports promise to increase the safety of longwall mining in the future.

The evaluation of safety for the demonstration longwall is based on accident reports submitted during the course of the project. It should be noted that both federal law and company policy require all accidents, irregardless of how minor, to be reported. Even though some minor injuries are not reported, it is believed that the records are accurate enough to provide a valid evaluation. A chronologic log of all accidents reported are included in Appendix 3.

The shield demonstration face operated for 42 months. During this time, 114 accidents were reported to have occurred on the demonstration panels. Of these 114 accidents, six resulted in lost time and two could be considered serious. The accident frequency rate for the demonstration panels was 36 accidents per million man hours worked.

The safety evaluation for the demonstration longwall has been broken down according to four classifications. These classifications are: the type of job performed by the injured person; the type of accident which occurred; the type of equipment involved in the accident; and the type of injury sustained from the accident.

Type of Job Classification

Table III shows the number of accidents on the demonstration panels broken down according to the job performed by the injured worker. This table indicates that unskilled laborers were involved in the largest number of accidents. These employees were involved in 24 accidents or 21% of the total number of accidents which occurred on the demonstration longwall. Unskilled laborers usually have the least mining experience and are often used to fill in for employees absent from their regular jobs. Not being regular employees on the longwall, these people may be less familiar with the inherent dangers of any job classification. Utility men were involved in the second largest

TABLE III

NUMBER OF ACCIDENTS FOR EACH JOB CLASSIFICATION

JOB CLASSIFICATION	4-North Shield 4/75-5/76	5-North Shield 7/76-5/77	6-North Shield 8/77-9/78	Shield Moves	Total	%
Shear Operator	5	1, 1LT	2	1	10	8.8
Propman	2	3	9	1	15	13.2
Mechanic	5, 1LT	5	2, 1LT	2, 1LT	17	14.9
Headgate men	7	1	1	2	11	9.6
Tailgate man	1	0	0	0	1	0.9
Utility man	5	5, 1LT	9	0	20	17.5
Trainee	4	2	1	0	7	6.1
Unskilled	5, 1LT	8	6	4	24	21.1
Section Foreman	0	1	5	0	6	5.3
Other	1	0	2	0	3	2.6
TOTAL	37	28	38	11	114	100
Lost Time	2	2	1	1	6	5.2

number of accidents with 20. This represents 18% of the total number of demonstration longwall accidents. These men are regularly assigned to the longwall but do various jobs on the panel each day. As with the unskilled laborers, these men do not have a regular day to day routine where they can establish safe work habits. The propmen, whose jobs are most directly related to the shields, were involved in 13 accidents or 8% of the total number of accidents. Nine of these thirteen accidents occurred on panel 6-North where poor conditions existed.

There were a total of six lost time accidents during the three panel demonstration. Three of these lost time accidents involved mechanics. Of these six lost time accidents, two could be considered serious. One of these accidents occurred on panel 4-North. In this incident, a propman put his thumb in a hole in the hydraulic leg cover and lowered the shield. A hydraulic fitting which accessed through the hole cut off the end of the man's thumb at the first joint. The other serious accident occurred during the move from panel 5-North to panel 6-North. While changing the hinge position of the shield, a chain which was supporting the shield, broke and the shield collapsed. The mechanic working on the shield had his hand crushed between the shield controls and the shield base as it collapsed.

The results obtained on the demonstration panels correlate very well with a study performed between 1973 and 1975 by Pennsylvania Mines Corp. at their Greenwich Collieries (Merrit and Davis, 1977, p. 62). In this study, longwall helpers (laborers and utility men) accounted for the majority of accidents. Table IV presents the results of safety data collected by the Mining Enforcement and Safety Administration's Health and Safety Analysis Center at Denver. These statistics were collected from 51 coal mines using longwalls in 1975 and 60 mines in the first nine months of 1976. This table indicates that the propmen on the demonstration panels were involved in a lower percentage of accidents than the average but unskilled laborers and utility men were involved in a higher percentage of accidents.

Type of Accident

Table V shows the number of accidents on the demonstration panels broken down according to the type of accident which occurred. This table indicates that the largest percentage of accidents were a result of striking or bumping some object other than coal or rock. This category includes being hit by or pinched between two objects. Twenty-eight of the accidents or 25% of the total accidents were in this category. Four of the six lost time accidents were a result of this kind of accident. Roof fall accidents accounted for 19 of the accidents or 17% of the total accidents. This type of accident is defined as any piece of rock which falls from the roof and results in injury. Roof fall accidents may or may not be associated with the shield supports, depending on how and where the accident occurred. Eleven of the 19 roof fall accidents occurred on Panel 6-North where poor conditions existed. Only one of these accidents was a result of a major roof fall. This accident occurred while cleaning up the fall and not during the fall itself. Most of the roof fall accidents resulted from rocks smaller than 10 lbs falling between or in front of the shields when the shields were being advanced. Lifting or pulling accidents resulted in 18 accidents or 16% of the total accidents. These accidents are a result of workers trying to lift too much or lifting in an improper fashion.

TABLE IV

1975 & 1976 MESA SAFETY DATA

Type of Accident	1975	1976 Jan-Sept.	Percent
Fall of roof	77	55	18
Machinery	71	52	17
Handling Material	60	71	18
Hand tool	32	30	9
Lifting/pulling	32	29	8
Slip or fall	29	27	8
Sliding/falling material	21	15	5
Striking/bumping	19	14	5
Haulage	9	21	4
Fall of face-rib-side	8	10	2
All others	27	20	6
Total	385	344	100

Job Title			
Jacksetter, longwall	106	97	28
Laborer	65	61	17
Shear/plow operator	48	47	13
Mechanic	40	45	12
Section Foreman	26	19	6
Tmbrmn, prpmn, jkstr.	14	10	3
Belt, conveyor man	13	9	3
Maintenance foreman	6	6	2
Electrician	5	3	1
Motorman	4	13	2
All others	58	34	13
Total	385	344	100

TABLE V

NUMBER OF EACH TYPE OF ACCIDENT

TYPE OF ACCIDENT	4-North Shield 4/75-5/76	5-North Shield 7/76-5/77	6-North Shield 8/77-9/78	Shield Moves	Total	%
Slipping, Tripping	4, 1LT	3	3	3	14	12.2
Fall of roof	2	6	11	0	19	16.7
Fall of Face	1	1, 1LT	1	0	4	3.6
Fall of Rib	1	2	3	0	6	5.2
Lifting, Pulling	12	2	3	1	18	15.7
Hand Tool	2	3	3	1	9	7.9
Handling Material	4	3	2	2	11	9.6
Striking, Bumping against	8, 1LT	6, 1LT	7, 1LT	3, 1LT	28	24.6
Stepping on object	0	0	0	0	0	0
Object In Eye	1	0	3	0	4	3.6
Other	0	0	1	0	1	0.9
Total	37	28	38	11	114	100
Lost Time	2	2	1	1	6	5.2

This type of accident usually results in muscle strain.

Table IV presents the MESA results for the types of accidents which occurred on longwall panels. This table is the best available information but is not normalized to the same conditions present on the demonstration panels. This table indicates that the percentage of roof fall accidents on the demonstration panels were very close to the average obtained in the study. Striking and bumping accidents and lifting and pulling accidents during the demonstration were much higher than the average. These differences may be a result of slightly different accounting procedures.

Type of Equipment Involved

Table VI shows the number of accidents on the demonstration panels broken down according to the type of equipment which was involved in the accident. This table shows that 39 accidents or 34% of the total accidents did not involve equipment or machinery. The demonstration shields were involved in 27 accidents or 24% of the total accidents. Some common types of shield related accidents are: rocks falling on the tops of shields and striking workers; tripping over or slipping on shield bases; falling against the shields; pinching the feet between the DA rams and the face conveyor. Three of the lost time accidents involved the shields. Since all of the workers on a longwall panel are continually in contact with the roof support equipment, it is logical that many accidents would involve these supports.

Type of Injury Sustained

Table VII shows the number of accidents on the demonstration panels broken down according to the type of injury which resulted from the accident. The majority of accidents resulted in bruises. This type of injury was involved in 61 accidents or 54% of the total accidents. This value is similar to the results obtained in the Pennsylvania Mines Corp. (Merrit and Davis, 1977, p. 60). The two broken bone injuries on the 5 North panel were associated with the roof supports.

Maintenance

The demonstration shields were relatively free of major maintenance problems. The small percentage of longwall downtime attributed to the shields is a result of good engineering design and rugged shield construction.

Coal was produced two shifts a day and five days a week during the demonstration. The third shift was primarily a maintenance shift. Belt moves, power moves, equipment repairs, and preventative maintenance were performed on this shift. If possible, major equipment repairs were performed on the maintenance shift so that production was not interrupted. Minor repairs were routinely made on the production shifts as well as major repairs which were necessary for production to continue. These types of repairs were responsible for any downtime attributed to the shields.

A longwall maintenance study was performed on panel 4-North by Jet Propulsion Laboratory (JPL). This report is entitled "Longwall Mine Availability and Delay Analysis, Phase II" Technical analysis, NTIS #Fe/9012-2, April 1978, and can be obtained from the U. S. Bureau of Mines.

TABLE VI

NUMBER OF ACCIDENTS FOR EACH TYPE OF MACHINERY

MACHINERY INVOLVED	4-North Shield 4/75-5/76	5-North Shield 7/76-5/77	6-North Shield 8/77-9/78	Shield Moves	Total	%
Shearer	3	3, 1LT	0	0	7	6.1
Face Conveyor	3	2	7, 1LT	0	13	11.4
Roof Supports	9, 1LT	5, 1LT	10	0, 1LT	27	23.7
Stage Loader	1, 1LT	0	0	0	2	1.8
Conveyor Belt	1	2	2	0	5	4.5
Hand Tool	2	2	2	1	7	6.1
None	14	10	10	5	39	34.2
Other	2	2	6	4	14	12.2
Total	37	28	38	11	114	100
Lost Time	2	2	1	1	6	5.2

TABLE VII

NUMBER OF EACH TYPE OF INJURY

TYPE OF INJURY	4-North Shield 4/75-5/76	5-North Shield 7/76-5/77	6-North Shield 8/77-9/78	Shield Moves	Total	%
Sprain	2, 1LT	1	2	2	8	7.0
Bruise	15	18	24	4	61	53.5
Cut	2, 1LT	3	2	2	10	8.8
Broken Bone	0	0, 2LT	2, 1LT	0, 1LT	6	5.2
Strain	13	4	4	2	23	20.2
Burn	1	0	0	0	1	0.9
Eye	2	0	3	0	5	4.4
Total	37	28	38	11	114	100
Lost Time	1	2	1	1	6	5.2

The maintenance study analyzed the daily production reports filled out by the longwall foreman after each shift. This study investigated all delays which took place during each shift. External delays included travel time, conveyor delays, power problems, and any other source of delay time which did not occur at the face. Internal delays were delays which occurred at the face. The JPL report found that panel 4 North had a longwall availability of 76.5%. The delays attributed to the shields were only 4.5% of the internal delays and only 2.7% of the total delays. Table VIII shows the distribution of delay times for the shields on panel 4-North. Panels 5-North and 6-North experienced more shield maintenance problems than panel 4-North due to poorer conditions and increased age of the equipment. Even with this increase, shield maintenance accounted for a very minor percentage of longwall downtime and repair. Table IX shows the major shield components which were replaced during the three panel demonstration. The insignificant items such as hydraulic hoses, nuts and bolts are not included in this table.

The most frequently replaced shield components were the hydraulic control valves. These valves were replaced at the first sign of trouble on a routine basis. The major cause of valve failure was due to the contamination of the water system with fine sediments. These sediments entered the shield hydraulic system from the outside water supply. The filters between the pumps and the shields were unable to remove all the sediment and wear inside the valves resulted. Replacement of these valves was very simple and was often performed on production shifts without any interruption of production. The valves were easily rebuilt in Kaiser's maintenance shop.

The second highest replacement items were the DA rams. Sixty of these rams were replaced during the life of the demonstration project. Most of the rams were damaged when the cylinders became bent. A major cause of DA ram damage was the misalignment of the shields behind the face conveyor. This often occurred in areas with a sloping or soft floor. Loose rocks which jammed between the cylinder and the shield base also damaged many rams. The poor roof and floor conditions on panel 6-North resulted in the replacement of 31 rams on that panel.

Yield valves were also commonly replaced items due to sediment wear. Early in the project, all spring activated yield valves were replaced with gas filled valves upon Hemscheidt's recommendation. Some of these valves were replaced a second time back to the original valves and are not shown on the report because they were not reported. A total of 46 yield valves were replaced due to valve failure.

Fifteen hydraulic shield legs were replaced during the demonstration. The majority of the legs were bent when the legs became iron bound. This problem was a result of having the leg extensions adjusted too high for the mining height. Legs were also bent when trying to climb upgrade in high mining heights. This resulted in both the shields and shield legs leaning backward. The legs were not designed for loading in this manner and were bent. Five legs were damaged in this manner during April, 1978.

Production

During the course of the longwall demonstration, 902,430 metric tons (994,929 short tons) of raw coal were produced in 1159 shifts. The average production for the project was 778 metric tons (858 short tons) per shift. Tables X, XI, & XII show the monthly production for each of the three demonstration panels. Panel 4-North averaged 817 metric tons (901 short

TABLE VIII

DISTRIBUTION OF DELAY TIMES FOR THE SUPPORTS

DELAY DESCRIPTION	TOTAL DELAY IN MINUTES	NUMBER OF DELAYS	AVERAGE DELAY TIME IN MINUTES
Adjusted, fixed, serviced	555	5	111
Broken, wouldn't work	45	1	45
Clevis broken	170	3	56
Dual-action ram	35	2	17
Fell in hole/rib	65	2	32
Hung up, stuck	600	1	15
Wouldn't come in	600	3	200
All supports delays	1,485	17	87

(from JPL report, December 1976, p. V-11)

TABLE IX a

NUMBER OF MAJOR PARTS TO BE REPLACED EACH MONTH

	May 1975	June 1975	July 1975	August 1975	September 1975	October 1975	November 1975	December 1975	January 1976	February 1976	March 1976	April 1976	May 1976	June 1976	July 1976	August 1976	September 1976	October 1976	November 1976	December 1976
Control valves	8		3	27	1		1		19		12	12				3	6	12	4	
DA Rams		2	1		1				4	1	2	1					5	2	3	1
Shield legs																				2
Side shield rams					1				1											
Canopy ext. rams																		1	1	1
Face guard rams																			1	
Yield valves							*234													
Support bridge									1											
Total	8	2	4	27	3		235		25	1	14	13				3	11	15	9	4

* All spring activated yield valves were replaced with gas filled valves upon Hemscheidt's recommendation

TABLE IX b

NUMBER OF MAJOR PARTS TO BE REPLACED EACH MONTH

	January 1977	February 1977	March 1977	April 1977	May 1977	June 1977	July 1977	August 1977	September 1977	October 1977	November 1977	December 1977	January 1978	February 1978	March 1978	April 1978	May 1978	June 1978	July 1978	August 1978	September 1978	
Control valves	13			12			1	12	8	20	21	2				10	5	32	7	23	4	195
DA Rams	2	3			1			3	1	6	5				1	3	8	3	1			60
Shield legs	2	1	1					2		1	1					5						15
Side shield rams																						2
Canopy ext. rams																						3
Face guard rams																						1
Yield valves	3			2	2			6		2	3							1	1	26		280
Support bridge																						1
Total	20	4	1	14	3		1	23	9	29	30	2			1	18	13	36	9	49	4	

TABLE X

MONTHLY PRODUCTION FIGURES FOR PANEL 4-NORTH

MONTH		SHIFTS	TONS/SHIFT HIGH	TONS/SHIFT AVE.	TONS/DAY HIGH	TONS/DAY AVE.	MONTHLY RAW TONS	MONTHLY FACE ADVANCE	COMMENTS
MAY	75	28	1484	749	2578	1498	20,960	89	
JUNE	75	42	1755	836	3291	1672	35,108	160	
JULY	75	16	1480	1083	2812	2166	17,330	73	
AUGUST	75	40	1580	841	2820	1682	33,630	154	
SEPTEMBER	75	32	1410	841	2405	1682	26,926	103	
OCTOBER	75	41	1969	1106	3294	2212	45,347	207	
NOVEMBER	75	26	1683	1079	2950	2158	28,048	128	
DECEMBER	75	34	1575	966	2771	1932	32,855	165	
JANUARY	76	36	1794	1148	3068	2296	41,339	187	
FEBRUARY	76	28	1654	1024	2957	2048	28,662	125	
MARCH	76	33	1468	916	2385	1832	30,242	128	
APRIL	76	30	1575	648	2069	1296	19,425	83	
MAY	76	19	473	265	666	530	5,032	22	
TOTALS		405					364,904	1624	
AVERAGE -		31		901		1802	28.070	125	

TABLE XI

MONTHLY PRODUCTION FIGURES FOR PANEL 5-NORTH

MONTH		SHIFTS	TONS/SHIFT HIGH	TONS/SHIFT AVE.	TONS/DAY HIGH	TONS/DAY AVE.	MONTHLY RAW TONS	MONTHLY FACE ADVANCE	COMMENTS
AUGUST	76	44	1864	996	2928	1992	41,624	230	
SEPTEMBER	76	42	1760	1016	2910	2032	42,668	243	
OCTOBER	76	26	2322	1385	4179	2770	36,016	190	
NOVEMBER	76	28	2117	1376	3863	2752	38,528	211	
DECEMBER	76	26	1840	1079	2847	2158	28,067	150	
JANUARY	77	30	1800	1019	2622	2038	30,567	166	
FEBRUARY	77	30	1362	1026	2409	2052	30,769	195	
MARCH	77	38	1654	1030	2977	2060	39,145	241	
APRIL	77	39	2200	1290	3518	2580	50,313	310	
MAY	77	17	1962	534	3304	1068	8,551	60	
TOTAL		320					346,158	1996	
AVERAGE		32		1082		2164	34,616	200	

TABLE XII

MONTHLY PRODUCTION FIGURES FOR PANEL 6-NORTH

MONTH		SHIFTS	TONS/SHIFT HIGH	TONS/SHIFT AVE.	TONS/DAY HIGH	TONS/DAY AVE.	MONTHLY RAW TONS	MONTHLY FACE ADVANCE	COMMENTS
JUNE	77								Moving from 5N to 6N
JULY	77								Moving from 5N to 6N
AUGUST	77	41	2040	963	2932	1926	39,465	190	
SEPTEMBER	77	41	1857	946	3132	1892	38,790	202	
OCTOBER	77	45	1547	872	2393	1744	39,235	200	
NOVEMBER	77	41	1700	553	2550	1106	22,687	115	
DECEMBER	77	5	824	636	1436	1272	3,179	19	Contract Strike
MARCH	78	10	816	419	1241	838	4,190	24	12/5/77 - 3/26/78
APRIL	78	45	1600	742	3292	1591	33,403	186	
MAY	78	50	1725	643	2885	1607	32,148	177	
JUNE	78	53	1240	622	2800	1555	32,957	183	
JULY	78	39	960	469	1912	938	18,275	107	
AUGUST	78	39	900	360	1700	834	15,858	94	
SEPTEMBER	78	20	672	184	964	368	3,680	23	
TOTALS		434					283,867	1520	
AVERAGE		36		654		1306	23,656	127	

tons) per shift; panel 5-North averaged 981 metric tons (1082 short tons) per shift; and panel 6-North average 593 metric tons (654 short tons) per shift.

Accurate statistics are difficult to obtain, but on an average, the longwall faces operating at the same time as the York Canyon demonstration were producing between 635 and 816 metric tons (700 and 900 short tons) per shift (Merrit and Davis, 1977, p.60). Even with the extremely poor production on panel 6-North, the average production for the entire project fell within acceptable limits. Production for panels 4-North and 5-North was well above the average. The U. S. Bureau of Mines predicts that the average for U. S. longwalls will be approximately 907 metric tons (1,000 short tons) per shift by 1980 (Merrit and Davis, 1977, p. 60). It should be noted that panel 5-North produced above this predicted average in 1976 and 1977.

Production on the demonstration was both enhanced and retarded by the high seam heights. On one hand, the high coal enabled more coal to be mined for each shear pass. On the other hand, the high coal resulted in the generation of large lumps which slowed production. The lump problems prevented any real records from being set during the demonstration. Problems with the face conveyor on all three panels also contributed to lower average production for the porject. The shields themselves, contributed to higher production on panels 4-North and 5-North because of their low maintenance, high availability, and ease of operation. On panel 6-North, the shields contributed to lower production because they were adjusted for low coal conditions and operating in high coal conditions. Under these conditions, the shields were unable to effectively support the roof and major roof falls resulted. This led to reduced production due to shifts lost cleaning up falls and time to support the gate entries.

Rcof Control

In general, the shield supports proved to be a very safe and productive support method. On panel 4-North and 5-North, conditions were almost ideal. The shields provided excellent face support on these panels and very few roof control problems were encountered. The skin to skin arrangement and gob shield provided excellent protection from the caved material. The shields proved to be very stable in faulted areas and had little or no problems negotiating under these conditions.

On panel 6-North, the shields were unable to effectively support the roof. This was partially due to poorer roof conditions which existed on that panel. The major reason for the poor shield performance was that the shields were operating in high seam conditions and adjusted for low seam conditions. In the low seam setting, the caliper type shield canopies were often several feet from the face. This resulted in poor roof resistance and shield instability in high seam conditions. Once mining began, it was not possible to change the shield settings and roof control problems existed throughout panel 6-North. Had the shields been properly adjusted for the conditions encountered, they might have been able to provide as good a support system as on the other panels.

Labor Evaluation

The success or failure of a new mining concept is largely influenced by the acceptance of that concept by the people who work in the mines.

In general, the miners thought that the shield longwall was a safe place to work. The first two panels provided very safe and comfortable working conditions. Conditions on panel 6-North were much more difficult. It was generally thought that the shield supports were much better than the previously used chock supports. The time to advance the shields was less than the chocks and a better travelway provided better working conditions. The lemniscate shields used on panel 6-Left were thought to be superior to the caliper type demonstration shields.

The miners also approved of the face lighting. This lighting made it easier to align the face conveyor and illuminated the travelway. Better access and better working conditions resulted. Maintenance personnel considered the lighting system as a liability because it continually malfunctioned.

The miners preferred the one web back system of mining over the other systems because better working conditions resulted. This system was readily sacrificed when other systems provided better roof control.

The only portion of the longwall demonstration which the miners did not approve of was the chain haulage system. When the face was not properly aligned, the chain would bounce over the conveyor spill plates into the travelway. To eliminate this problem, future longwalls at Kaiser will probably be equipped with a chainless haulage system. Chainless haulage does, however, have operating constraints. It is difficult to operate on an undulating floor because of operating constraints of 1.5 to 3 degrees of vertical displacement. The chainless haulage system travels slower than the chain haulage system.

COMPARISON OF ROOF SUPPORTS AT YORK CANYON

One of the objectives of the demonstration was to compare the performance of the demonstration panels with the other longwall panels operating at York Canyon. Kaiser operated a chock longwall when panels 4 North and 5-North were being mined and another shield longwall when panel 6-North was being mined. The chocks operated in panel 8-Right when the demonstration began and were moved to panel 5-Left in December 1975 and January 1976. This panel operated until August 1977. The chocks were replaced at this time and a second shield longwall face began operations on panel 6-Left in October 1977.

Figures 25 and 26 are detail drawings of the chocks used at York Canyon. These chocks were Dowty 450 ton, 4-leg chock supports. A total of five longwall panels were mined with these supports. The last two chock panels were mined during the demonstration. Figures 27 and 28 are maps of these two panels showing the monthly face advances. Panel 8-Right was 204 m (670 ft.) wide, 1.82 m (6 ft.) high, and 395 m (1625 ft.) long. The last 244 m (800 ft.) of this panel was mined after panel 4-North began operating. Panel 5-Left was 152 m (500 ft.) wide, 1.98 m (6.5 ft.) high, and 896 m (2940 ft.) long. This panel operated at the same time as both panels 4-North and 5-North.

Panel 6-Left began operations in October, 1977. This face used Hemscheidt G320, Lemniscate, 350 ton capacity shields. These shields were similar in design to the demonstration shields except that they were lemniscate rather than caliper type shields. These shields were also designed to operate in lower seam heights. Panel 6-Left was 160 m (525 ft.) wide, 1.98 m (6.5 ft.) high, and 1960 m (6430 ft.) long. The first 564 m (1850 ft.) of this panel was mined while panel 6-North was operating. Figure 29 shows the monthly face advance for panel 6-Left.

Safety

During this demonstration project 106 accidents were reported on the three non-demonstration longwall panels. The two chock panels had 96 reported accidents and the 6-Left shield panel had 10 accidents. Tables XIII, XIV, IV, and XVI show the number of accidents on all longwall panels at York Canyon broken down by the job classification of the injured, type of accident which occurred, type of equipment involved in the accident, and the type of injury sustained in the accident. When comparing the safety of the three types of supports used at York Canyon, the demonstration shields were superior to the chock type supports but inferior to the lemniscate type shield supports. Appendix 4 includes accident frequency comparisons for the longwalls operating during the interim of this report.

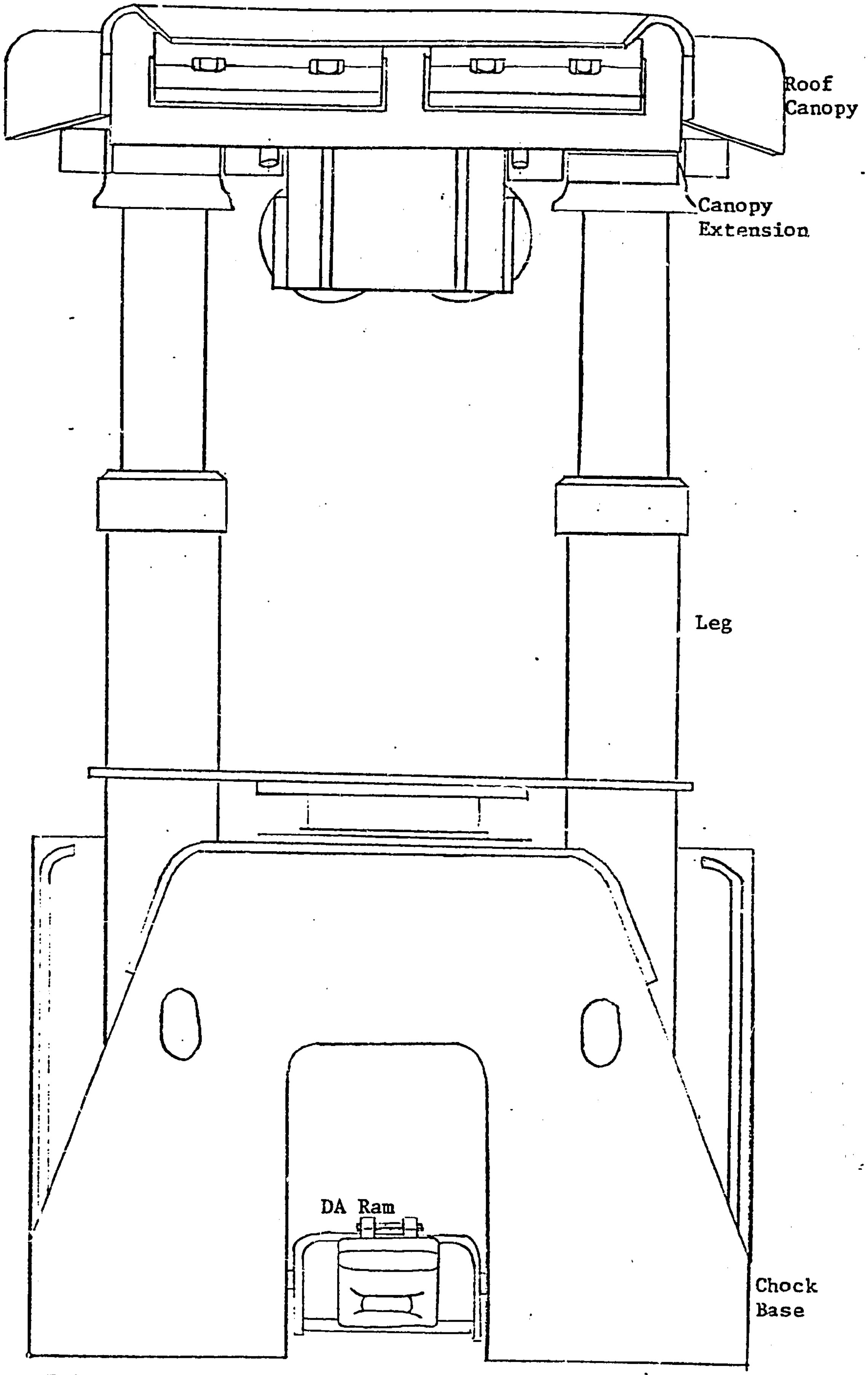


FIGURE 25; Frontal view of Dowty Chocks. Scale = 1/8 F.S.

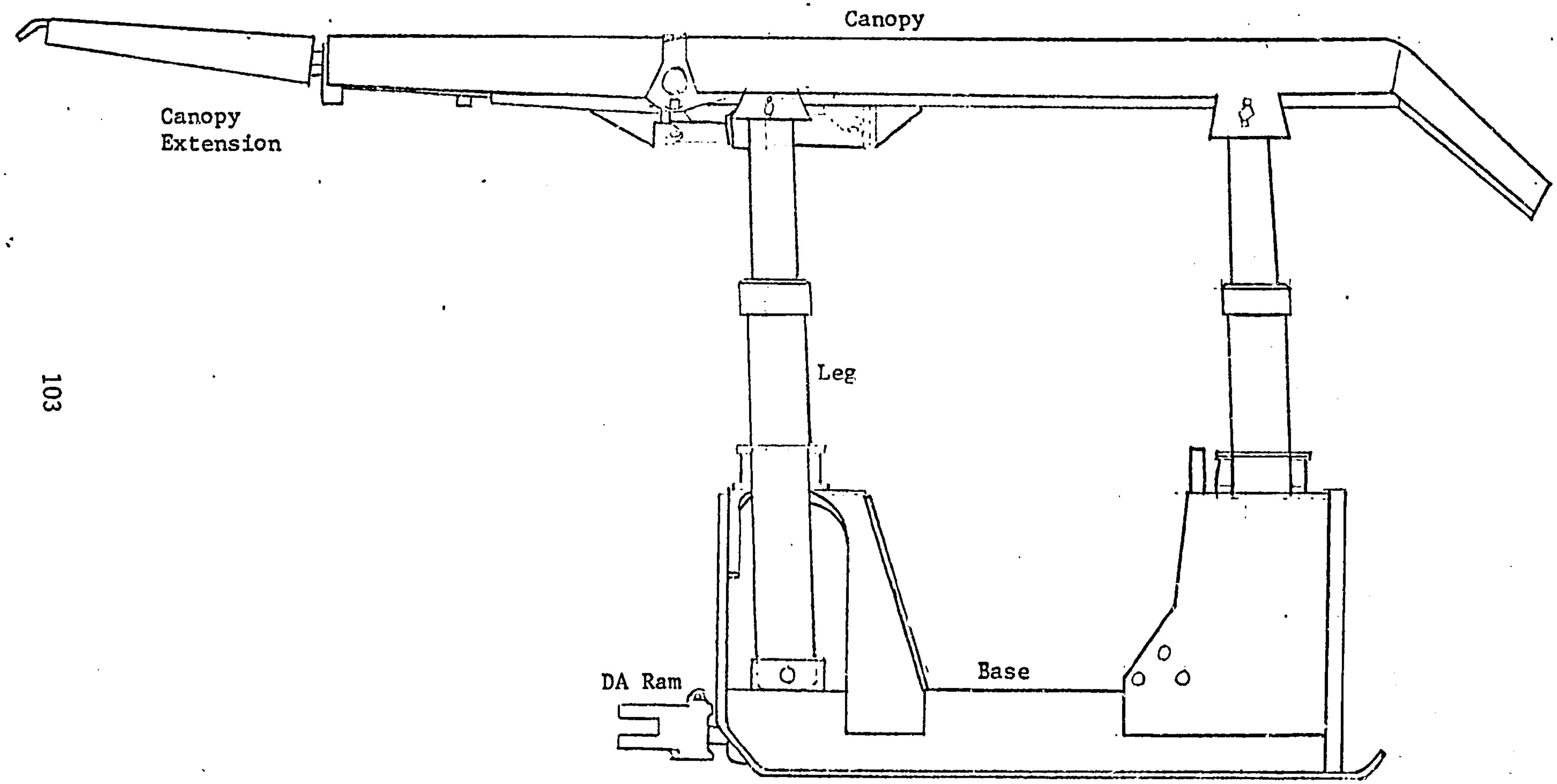


FIGURE 26; Side view of Dowty Chocks. Scale = 1/16 F.S.

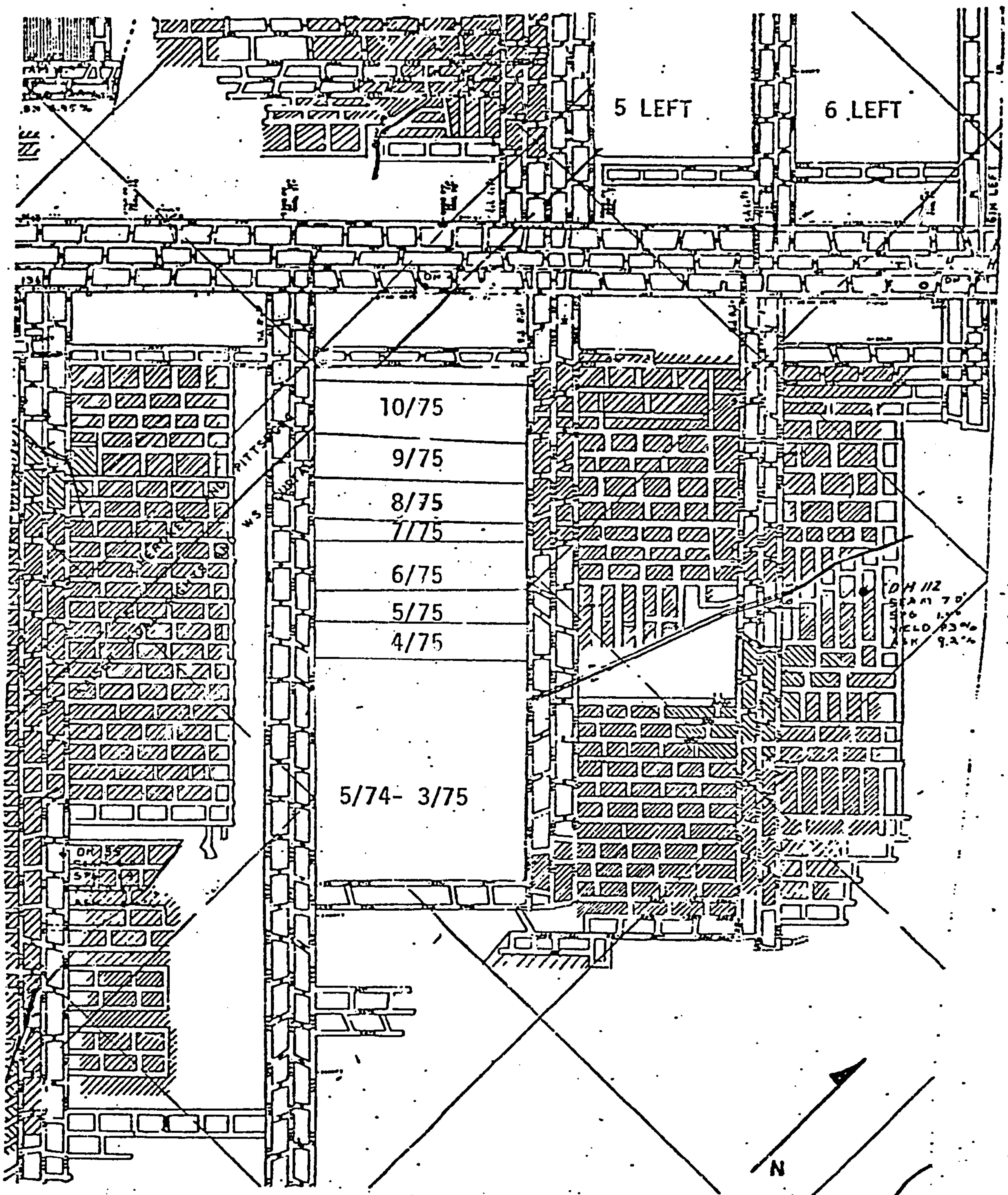


FIGURE 27 Monthly face advance of 8 Right chock longwall.

Scale 1"=500'

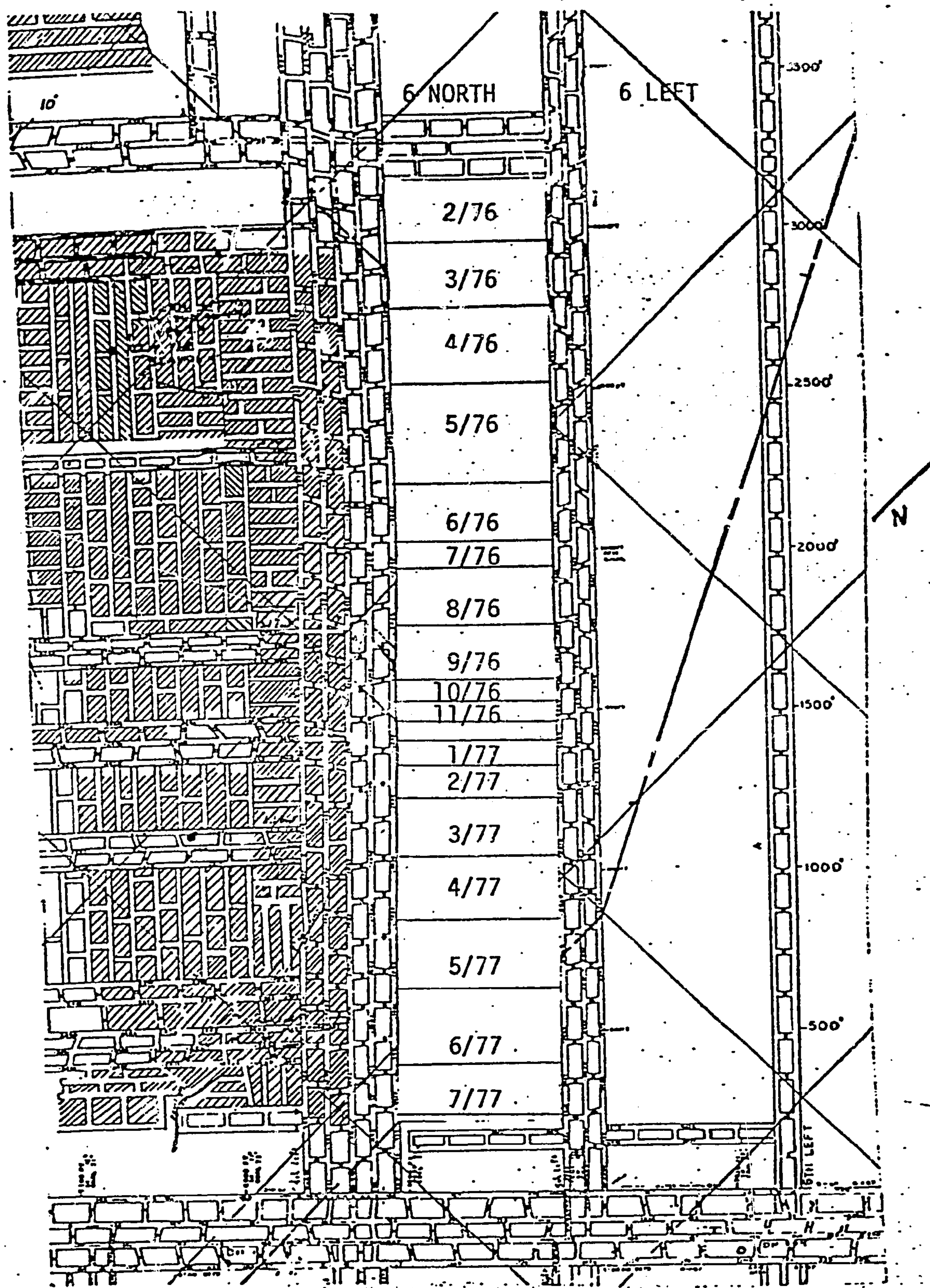


FIGURE 28 Monthly face advance of 5 Left chock longwall

Scale 1"=500'

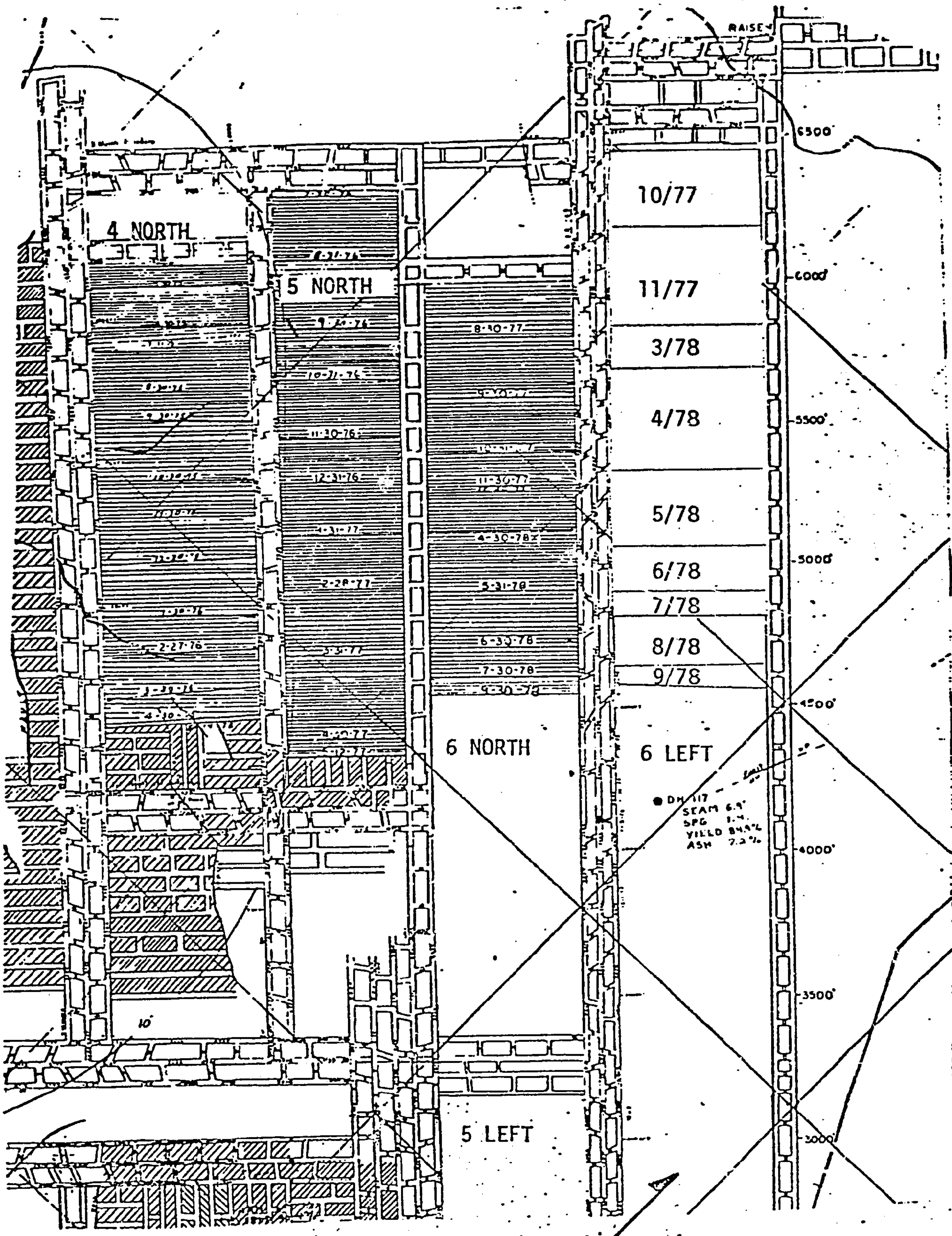


FIGURE 29 Monthly face advance of 6 left shield longwall.

Scale 1"=500'

NUMBER OF ACCIDENTS

JOB CLASSIFICATION	8RIGHT CHOCK 4/75-12/75	4NORTH SHIELD 4/75-5/76	5LEFT CHOCK 1/76-7/77	5NORTH SHIELD 7/76-5/77	6LEFT KAISER SHIELD 9/77-9/78	6NORTH SHIELD 8/77-9/78	CHOCK MOVES	SHIELD MOVES	TOTAL
Shear Operator	6	5	9	1, 1LT	0	2	0	1	25
ropman	7	2	8, 1LT	3	3	9	2	1	36
echanic	6	5, 1LT	5	5	1	2, 1LT	2	2, 1LT	31
eadgate men	2	7	5, 1LT	1	1	1	1	2	21
ailgate man	1	1	0	0	0	0	2	0	4
tility man	5	5	7	5, 1LT	3	9	1	0	36
rainee	3	4	1	2	1	1	0	0	12
nskilled	1	5, 1LT	9	8	0	6	1	4	35
ection Foreman	3	0	4	1	0	5	0	0	13
ther	1LT	1	2	0	1	2	0	0	7
OTAL	35	37	52	28	10	38	9	11	220
ost Time	1	2	2	2	0	1	0	1	9

Table XIII Number of accidents for each job classification

NUMBER OF ACCIDENTS

PE OF ACCIDENT	8RIGHT CHOCK 4/75-12/75	4NORTH SHIELD 4/75-5/76	5LEFT CHOCK 1/76-7/77	5NORTH SHIELD 7/76-5/77	6LEFT KAISER SHIELD 9/77-9/78	6NORTH SHIELD 8/77-9/78	CHOCK MOVES	SHIELD MOVES	TOTAL
ippin, Tripping, Falling	4, 1LT	4, 1LT	7	3	1	3	2	3	29
ll of Roof	5	2	22, 1LT	6	3	11	1	0	51
ll of Face	1	1	3, 1LT	1, 1LT	0	1	0	0	9
ll of Rib	1	1	0	2	0	3	0	0	7
fting, Pulling	6	12	2	2	0	3	0	1	26
nd Tool	3	2	2	3	1	3	1	1	16
ndling Material	3	4	1	3	0	2	0	2	15
iking, Bumping ainst	10	8, 1LT	10	6, 1LT	4	7, 1LT	3	3, 1LT	55
epping on object	0	0	0	0	0	0	1	0	1
ect in eye	0	1	2	0	1	3	0	0	7
her	1	0	1	0	0	1	1	0	4
AL	35	37	52	28	10	38	9	11	220
t Time	1	2	2	2	0	1	0	1	9

Table XIV Number of each type accident

NUMBER OF ACCIDENTS

MACHINERY INVOLVED	8RIGHT CHOCK 4/75-12/75	4NORTH SHIELD 4/75-5/76	5LEFT CHOCK 1/76-7/77	5NORTH SHIELD 7/76-5/77	6LEFT KAISER SHIELD 9/77-9/78	6NORTH SHIELD 8/77-9/78	CHOCK MOVES	SHIELD MOVES	TOTAL
Shearer	3	3	6, 1LT	3, 1LT	0	0	0	0	17
Face Conveyor	0, 1LT	3	5	2	0	7, 1LT	2	0	21
Roof Supports	12	9, 1LT	22	5, 1LT	2	10	1	0, 1LT	64
Stage Loader	2	1, 1LT	0	0	0	0	0	0	4
Conveyor Belt	4	1	3	2	1	2	1	0	14
Hand Tool	3	2	4	2	2	2	1	1	17
None	8	14	8	10	3	10	3	5	61
Other	2	2	2, 1LT	2	2	6	1	4	22
Total	35	37	52	28	10	38	9	11	220
Lost Time	1	2	2	2	0	1	0	1	

Table XV Number of accidents for each type of machine

NUMBER OF ACCIDENTS

TYPE OF INJURY	8RIGHT CHOCK 4/75-12/75	4NORTH SHIELD 4/75-5/76	5LEFT CHOCK 1/76-7/77	5NORTH SHIELD 7/76-5/77	6LEFT KAISER SHIELD 9/77-9/78	6NORTH SHIELD 8/77-9/78	CHOCK MOVES	SHIELD MOVES	TOTAL
Sprain	2	2, 1LT	1, 1LT	1	2	2	1	2	15
Bruise	21, 1LT	15	35	18	6	24	6	4	130
Cut	1	2, 1LT	4	3	1	2	1	2	17
Broken Bone	0	0	2, 1LT	0, 2LT	0	2, 1LT	0	0, 1LT	9
Strain	10	13	3	4	0	4	1	2	37
Burn	0	1	0	0	0	0	0	0	1
Eye	0	2	5	0	1	3	0	0	11
TOTAL	35	37	52	28	10	38	9	11	220
Lost Time	1	1	2	2	0	1	0	1	

Table XVI Number of each type of injury

Chock Comparison

The two chock panels operated at the same time as the 4-North and 5-North demonstration panels. During the same time period, the demonstration longwalls had 76 accidents and the chock longwalls had 96 accidents. The chock supports were involved in 35 accidents. On panels 4-North and 5-North, the shield supports were involved in only 17 accidents. There were 29 roof fall accidents on the chock panels as opposed to 8 roof fall accidents on the two demonstration panels.

The better safety record of the shield demonstration faces is attributed to the safer working environment created by the shield supports. The skin to skin arrangement of the shields effectively prevented rock from falling between the shields. The chocks were designed with a 10 - 15cm(4 - 6 inch) gap between adjacent chock canopies. This allowed small rocks to fall between the chocks. Many of the roof fall accidents were caused by small rocks falling between the chocks and smashing hands and fingers against the conveyor spill plate.

Shield Comparison

Panel 6-Left operated at the same time as panel 6-North. This shield face was the safest and most productive of all the longwall panels at York Canyon. Roof geology on this panel was similar to that on Panel 6-North. The lemniscate shields on panel 6-Left controlled the poor roof and prevented roof deterioration. The panel also negotiated three faults during the demonstration. These faults caused very few problems. Only ten accidents were reported on panel 6-Left during the demonstration. This is less than one-third of the accidents on any other longwall panel for a one year period.

The superior safety record of the 6-Left face is credited to the lemniscate design of these shields. The lemniscate shields can be kept within one foot of the face at any mining height. This feature along with the skin to skin arrangement resulted in very good roof control and safe working conditions.

Production

Production statistics of all longwalls at York Canyon indicate that shield type supports result in a more productive mining system than chock type supports. Of the two shield type supports used, lemniscate shields resulted in more efficient operation and higher overall production than the caliper type supports. Appendix 5 is a list of daily production for all longwalls at York Canyon.

During the demonstration, an average production of 778 metric tons (858 short tons) per shift was obtained by the three demonstration panels. Panel 4-North averaged 817 metric tons (901 short tons) per shift; panel 5-North averaged 981 metric tons (1082 short tons) per shift; and panel 6-North averaged 593 metric tons (654 short tons) per shift.

Chock Comparison

The two chock panels operating at the same time as panels 4-North and 5-North averaged 620 metric tons (684 short tons) per shift. Panel 5-Left averaged 629 metric tons (693 short tons) per shift and panel 8 Right averaged 600 metric tons (661 short tons) per shift. These production rates were achieved in what was considered to be average conditions. Production figures show that the shield faces were able to produce 30.2% more coal than the chock faces during the same time period. When compared to panel 6-North which operated in poor conditions, the chock faces only averaged 4.4% more production. The chock panels had problems negotiating faults which accounted for some of the porduction differences.

Shield Comparison

Panel 6-Left was the most productive of all the longwall panels. This panel averaged 990 metric tons (1091 short tons) per shift. This value is not a true reflection of the production potential on panel 6 Left. Panel 6-Left was forced to limit production for several months to keep from passing panel 6-North. Before production on panel 6-Left was limited, an average of 1416 metric tons (1561 short tons) per shift was obtained. This value represents 239% of the production obtained by panel 6-North in very similar geologic conditions. The 6-Left lemniscate shields produced even in the weakest of roof conditions.

Roof Control

Shield type supports provided much better roof control at York Canyon than chock type supports. The lemniscate type shields used on panel 6-Left were much more effective than the caliper type demonstration shields.

The basic shield design resulted in better roof control on the shield faces than on the chock faces. The shield design creates a support that produces both a vertical and a forward thrust during yielding. This feature maintains the integrity of the roof much better than chock supports. The chock supports are designed to provide only a vertical force. The Dowty chocks used at York Canyon also had a larger roof canopy than the shields and therefore had to support more roof than the shields. This means that the chocks had to exert more pressure to obtain the same roof resistance as the shields. The skin to skin arrangement of the shields allowed for easier mining under highly fractured roof. Roof control in fault zones was also easier with the shields because the legs could act independently. The superiority of the shield type supports is clearly demonstrated when the number of roof fall accidents on shield and chock faces in compared.

The lemniscate shields used on panel 6-Left proved to be much better roof supports than the caliper type demonstration shields. The lemniscate type shields were designed so that the roof canopy extension could be kept within one foot of the face at almost any mining height. This resulted in very good roof control and kept even highly fractured roof from falling out in front of the shields. Because of their improved design, the lemniscate type shields easily mined through conditions which the caliper type shields could not control. It should be noted that had the chock face been used where the shield faces mined, roof problems would probably have been unsurmountable. The highly fractured roof would have continually fallen between the chocks creating hazardous working conditions.

COSTS

A comparison of the costs of the different longwall mining methods is importan for any analysis to be complete. Appendix 6 is a monthly comparison of relative cost per ton figures for the demonstration panels and the other longwalls operating at the same time.

The total cost per net ton for the demonstration shield longwall panels was 88.7% of the chock panels. The cost for the demonstration shield panels was 116.3% of the costs on the 6-Left panel. Cost per ton figures are primarily influenced by productivity. The higher producing longwall panels, therefore, generate lower cost per ton figures.

Because of their heavy duty construction, shield life is more than chocks. Although it was not determined by the demonstration, the life of the shields could easily be 20 years. Any of the hydraulic components which malfunction can easily be replaced while operations are not halted and, therefore, no rebuilding of the shields is necessary. The life of the shields is partly determined by technology of new equipment which is an unknown variable. For example, the caliper type shields which were used in this demonstration are becoming obsolete with the design of the lemniscate type shields.

MOVES

Since the shields weigh twice as much as the chocks, panel moves are somewhat different for chocks than they are for shields. The chocks, which weigh 4.5 metric tons (5 short tons) each, could be moved in the bucket of a battery scoop tram. The shields, which weigh 9.1 metric tons (10 short tons), each had to be transported on a trailer pulled by the battery scoop tram. The battery scoop trams could make more trips with the chocks because of longer battery charges and faster trips. The chocks could also be pulled off of the face faster because they are more maneuverable than the shields.

There were no chock face moves which were equal in distance or other variables as the shield face moves. It is estimated, however, that if all other conditions were equal, the chock supports could be moved in approximately 60% of the time as the same number of shield supports.

CONCLUSIONS

In general, the shield longwall demonstration was a success. It provided a working model for industry, educational institutions, government and the public to observe and compare with other mining methods. Over the 42 month project, 350 people visited the demonstration site. Of these 350 people, 146 were from the coal industry, 108 were from mining schools, 61 were from government agencies, and 35 were from the general public.

The demonstration proved both the merits of longwall mining and of shield type supports. Longwall mining with shield supports provided good working conditions and a safe working environment. Because of good engineering design and rugged construction, the shields required very little maintenance. The shields had a 99.4% availability. The entire longwall system had a 76.5% availability including external delays. The face conveyor accounted for most of the internal delay time and had a 92% availability. The largest delay time was because of the face conveyor hanging up. Had the face conveyor been enclosed on the bottom, perhaps this problem would have been decreased. The demonstration longwalls produced well within acceptable national longwall averages. Panels 4-North and 5-North produced well above these averages. When operating within the design limits of the shields, excellent roof control was obtained. When operating outside these design limits, extremely poor roof control resulted. In general, everyone associated with the demonstration approved of the shields as a safe and productive mining method.

The demonstration was able to expose some of the problems associated with longwall mining. It demonstrated that more effective control of lumps is necessary to make longwall mining of thick seams truly successful. A shearing machine mounted lump breaker is available which could reduce these lump problems. In the area of health & safety, the project demonstrated that face lighting significantly improves the working environment, but the technology of face lighting has not yet produced a system which meets the maintenance and availability needs of the industry. In addition to this problem, a reliable and efficient longwall system for dust suppression still does not exist. There are, however, air stream helmets available which improves the quality of air which the miners breath.

When compared with other longwalls operating at York Canyon, the demonstration shields provided better roof control and a better working environment than chocks. This resulted in a safer, more productive and more economical mining system. The caliper type demonstration shields did not operate as effectively as the lemniscate type shields on panel 6-Left. The newer lemniscate type shields were able to control very poor roof conditions. The lemniscate shield longwall produced much better safety and production statistics than the demonstration panel.

APPENDIX 1

CHRONOLOGIC LOG OF EVENTS

MAY 1975 - SEPTEMBER 1978

1975

May 9	Start of 4 North Shield Demonstration Panel
May 19	Protection shield for flying coal installed on shearer
May 30	Production record for month - 2580 tons
June 26	Water sprays on gob shields tried, but quickly discontinued because of subsequent softening of floor
June 27	Production record for month - 3292 tons
July 3	Production record for month - 2517 tons
July 7	New 150 Hp motors installed on shield face conveyor
July 12-31	Miners vacation
Aug 8	Pump unloading valve set too high causes damage to several valves
	Production record for month - 2599 tons
Sept 13-21	Mine idle
Sept 24	Addition of 125 Hp motor to shield panel face conveyor
Sept 30	Production record for month - 2286 tons
Oct 17	Production record for panel - 3293 tons
Oct 31	Main conveyor belt down
Nov	Spring loaded yield valves replaced with gas activated yield valves
Nov 1	MESA approved face lighting electrical system
Nov 5	First chock panel completed (8 Right)
Nov 7-15	Mine idle
Nov 17	Production record for month - 2950 tons
Nov 27-30	Mine idle

Dec 23	Production record for month - 2771 tons
Dec 24-31	Mine idle
1976	
Jan 1-6	Mine idle
Jan 6-8	Main conveyor belt down
Jan 28	Second chock face started (5 Left)
	Production record for month - 3069 tons
Feb 6	Production record for month - 2957 tons
Feb 17	Main conveyor belt down
Feb 21-29	Mine idle
Feb 27	Violent initial cave damages 36 legs on chock face
Mar 5	Mine idle
Mar 18	Production record for month - 2435 tons
Mar 19	Mine idle
Mar 24	Shields encounter first fault
Mar 26	Mine idle
April 1-5	Mine idle
April 5	Production record for month - 2070 tons
April 9	Mine idle
April 16	Mine idle
April 28	Started wire mesh over shields preparing to move
May 4	Production record for month - 666 tons
May 14	Shield panel completed

1976

June 1	First shield withdrawn from 4 North Face
June 26 - July 12	Miners vacation
July 29	Electrical system for Anderson Mavor Shearer inspected and approved
July 30	First coal cut on 5 North Face
Aug 3-12	Motion picture crew shooting scenes
Aug 10	Initial cave occurs on 5 North Face
Aug 12	Monthly high daily production - 2928 tons
Aug 16-20	Soft roof conditions slow production
Aug 27	Broken stage loader chain
Sept 9	Monthly high daily production - 2910 tons
Sept 22	Roll in roof and floor encountered
Sept 23	This roll became a fault
Sept 28	Fault appeared in 5L chock Longwall
Oct 5	Fault had disappeared in 5 North
Oct 10-20	Attempts made to hold lumps using wooden rods
Oct 21	Monthly high daily production - 4179 tons
Oct 21	High Shift Production for 5 North - 2322 tons
Oct 23-31	Mine idle
Nov 5	Mine idle
Nov 9	Monthly high daily production - 3863 tons
Nov 12	Mine idle
Nov 19-29	Mine idle
Dec 3	Mine idle
Dec 10	Mine idle
Dec 16	Leg bent on shield #52

Dec 17	Mine idle
Dec 21	Monthly high daily production - 2847 tons
Dec 23-31	Mine idle
1977	
Jan 3	2 shield legs bent #52 yield valves were changed out
Jan 7	Mine idle
Jan 14	Mine idle
Jan 19-20	Wildcat strike
Jan 21	Mine idle
Jan 24	Monthly high daily production - 2012 tons
Jan 28	Mine idle
Feb 4	Mine idle
Feb 11	Mine idle
Feb 17	Monthly high daily production - 2441 tons
Feb 18	Mine idle
Feb 24-25	Mine idle
Feb 26	Klockner Ferromatic Chunk Breaker installed on stage loader
Feb 28	One fault disappeared in 5 Left Chock Face another fault began
March 4	Mine idle
March 9	#69 shield iron bound and bent t.g. leg
March 11	Mine idle
March 17	Tailgate drive motor went out
March 18	Mine idle
March 23	Mine idle Main belt broke
March 31	Monthly high daily production - 3020 tons
April 19	Mine idle Main belt broke
April 29	Monthly high daily production - 3518 tons

May 1	Monthly high daily production - 3304 tons
May 3	Started putting wire mesh over shields in preparation for move from 5N to 6N
May 12	5N Longwall finished, begin move to 6N
May 16	Disassembly of equipment began after cleanup and preparation to move
May 31	First shield moved from 5N to 6N
June 25-July 10	Miners vacation
Aug 1	6N Face starts up
Aug 1	5L chock Face finishes mining and begins move to 6L where shields will be used
Aug 9	Tailgate leg on shield #20 is bent and replaced
Aug 11	Tailgate leg on shield #58 is bent and replaced
Aug 12	Monthly high daily production - 2932 tons
Aug 12	Initial cave on 6N Face
Aug 17	Shields #67 & #68 iron bound and legs bent
Aug 23 & 24	Roof fall between #46 & #62 shields
Aug 29	High shift production record for 6N panel - 2040 tons
Sept 20	Monthly high daily production - 3132 tons
Sept 23	Face conveyor tailgate motor burned out
Sept 26	6L shield longwall started producing coal
October	Started working 6 days/week.
Oct 13	Face conveyor tailgate motor burned out
Oct 14	Face conveyor hung up all day
Oct 15	Roof fall at tailgate
Oct 17	Face tailgate motor bearing burned out
Oct 21	Monthly high daily production - 2393 tons
Nov 5	Monthly high daily production - 2550 tons
Nov 2	Face conveyor hung up

Nov 9	Roof fall between shields #23 - 38
Nov 16	Roof fall between shields #40-45
Nov 17	Started resin injection in tailgate entry
Nov 25	Mine idle Annual retraining
Nov 29	Mine idle Main belt broke
Dec 3	Face shut down preparation for contract Strike began
Dec 6	UMWA Contract strike began
1978	
Mar 27	UMWA Miners return to work
April 6	Mine idle Main belt broke
April 12	Started leaving bottom coal and taking shale split and roof seam to improve conditions
April 17	Started producing coal on midnight shift
April 20	Monthly High daily production - 3292 tons
May 9	Monthly high daily production - 2885 tons
May 24-25	Wildcat strike
June 8	Monthly high daily production - 2800 tons
June 8	6L shield longwall limited to 2 shears per shift to try and increase the distance between the two panels
June 23-July 9	Miners vacation, 6N panel crews work through vacation period
June 23 - July 23	6L shield longwall idle to try and stabilize 6N
July 6	Monthly high daily production - 1912 tons
July 24	6L shield longwall resume production, restricted to 3 shears/shift
Aug 3	Monthly high daily production - 900 tons
Aug 10	Minor roof fall
Aug 24-30	Roof falls continually occurred between shields #17-29 and a lip was not possible to establish

Sept 5	Monthly high daily production - 964 tons
Sept 7-10	Roof fall between shields 17 - 27
Sept 11-19	Worst roof fall of demonstration occurred between shields 17-27 Forepoling with 2" OD pipes establish a lip
Sept 29	Roof fall at headgate
Sept 29	Decision made to abandon section and drive entries through the panel to recover the shields

APPENDIX 2

DUST SAMPLES FOR ALL

6 LONGWALLS FROM 4/75-9/78

Dust samples were taken by Kaiser Steel personnel with MESA approved dust pumps.

DUST SAMPLES 8R 016-0

5/1/75 through end of panel

	# GOOD SAMPLES	# VOIDS	(Mg/M^3) TOTAL CONCENTRATION	(Mg/M^3) AVERAGE CONCENTRATION
TAILGATE MAN	118	11	275	2.33
SHEAR OPERATOR	4	1	10.3	2.58
PROPMAN	12	3	17.4	1.45
LABORER	0	0	0	0
SECT. FOREMAN	6	0	8.5	1.4
BELTMAN	0	0	0	0
MECHANIC	5	1	14.6	2.92
HEADGATE MAN	2	0	6.7	3.35
UTILITY MAN	2	0	2.3	1.15
INTAKE	4	0	1.0	0.25

NOTICES

NON-COMPLIANCE	COMPLIANCE
11	5

DUST SAMPLES 5L 022-0

	# GOOD SAMPLES	# VOIDS	(Mg/M^3) TOTAL CONCENTRATION	(Mg/M^3) AVERAGE CONCENTRATION
TAILGATE MAN	111	13	236.9	2.13
SHEAR OPERATOR	188	14	1018.9	5.42
PROPMAN	50	2	142.1	2.84
LABORER	8	1	12.5	1.56
SECT. FOREMAN	12	0	15.1	1.26
BELTMAN	0	0	0	0
MECHANIC	7	0	12.4	1.77
HEADGATE MAN	8	4	12.8	1.6
UTILITY MAN	1	0	5.4	5.4
INTAKE	7	0	.14	.02

NOTICES

NON-COMPLIANCE	COMPLIANCE
13	18

DUST SAMPLES 4N 028-0

	# GOOD SAMPLES	# VOIDS	(Mg/M^3) TOTAL CONCENTRATION	(Mg/M^3) AVERAGE CONCENTRATION
TAILGATE MAN	34	5	38.8	1.14
SHEAR OPERATOR	9	2	21.8	2.42
PROPMAN	79	5	249.6	3.16
LABORER	1	0	1.9	1.9
SECT. FOREMAN	8	0	4.8	.60
BELTMAN	0	0	0	0
MECHANIC	4	1	7.7	1.93
HEADGATE MAN	3	0	1.3	0.43
UTILITY MAN	2	0	3.3	1.65
INTAKE	6	0	1.0	.17

NOTICES

NON-COMPLIANCE	COMPLIANCE
7	23

DUST SAMPLES 5N 029-0

	# GOOD SAMPLES	# VOIDS	(Mg/M^3) TOTAL CONCENTRATION	(Mg/M^3) AVERAGE CONCENTRATION
TAILGATE MAN	200	24	540.1	2.7
SHEAR OPERATOR	9	1	27.6	3.07
PROPMAN	16	1	43.2	2.7
LABORER	6	1	16.4	2.73
SECT. FOREMAN	8	0	2.4	0.30
BELTMAN	0	0	0	0
MECHANIC	4	0	4.0	1.0
HEADGATE MAN	0	1	0	0
UTILITY MAN	4	0	7.6	1.9
INTAKE	3	0	1.1	0.37

NOTICES

NON-COMPLIANCE	COMPLIANCE
15	7

DUST SAMPLES 6N 032-0

	# GOOD SAMPLES	# VOIDS	(Mg/M^3) TOTAL CONCENTRATION	(Mg/M^3) AVERAGE CONCENTRATION
TAILGATE MAN	126	34	241.5	1.92
SHEAR OPERATOR	13	0	25.6	1.97
PROPMAN	22	1	42	1.91
LABORER	5	0	9.1	1.52
SECT. FOREMAN	7	0	6.0	.86
BELTMAN	1	1	.7	0.70
MECHANIC	6	0	14.8	2.43
HEADGATE MAN	4	0	2.3	.58
UTILITY MAN	3	0	7.7	2.57
INTAKE	4	0	1.2	.30

NOTICES

NON-COMPLIANCE	COMPLIANCE
6	12

DUST SAMPLES 6L 030-0

	# GOOD SAMPLES	# VOIDS	(Mg/M^3) TOTAL CONCENTRATION	(Mg/M^3) AVERAGE CONCENTRATION
TAILGATE MAN	142	27	491.3	3.46
SHEAR OPERATOR	3	0	10.4	3.47
PROPMAN	13	0	28.8	2.22
LABORER	7	0	16.4	2.34
SECT. FOREMAN	6	0	4.3	0.72
BELTMAN	0	0	0	0
MECHANIC	2	0	3.5	1.75
HEADGATE MAN	4	0	5.5	1.38
UTILITY MAN	3	1	14.5	4.83
INTAKE	3	0	0.3	0.1

NOTICES

NON-COMPLIANCE	COMPLIANCE
11	3

APPENDIX 3

CHRONOLOGICAL LOG OF ALL

LONGWALL ACCIDENTS 4/75-9/78

CHRONOLOGICAL LOG OF ACCIDENTS

5/7/75 8R	R. Lemons Minor Bruise	Pick glanced off rock & struck him on foot
5/10/75 8R	H. Moore Minor Bruise	Cables slipped from conveyor belt & struck left index finger & left leg
5/12/75 8R	K. Bacca Minor Strain	Strained right wrist while changing chock leg
5/14/75 8R	R. Gilbert Minor Strain	Twisted back while shovelling
5/14/75 8R	P. Manzanares Minor Strain	Lifting rock off stage loader & strained back
5/14/75 8R	C. Trujillo Minor Strain	Slipped and hurt back while walking through chocks
5/14/75 4N	J. Baca Minor Burn	Burned hand with cutting torch
5/14/75 4N	S. Gallegos Minor Bruise	Dropped steel plank on his ankle
5/16/75 4N	L. Sisneros Sprain	Sprained back while lifting hydraulic jack
5/22/75 8R	E. Romero Bruise	Rock fell on hand
5/29/75 8R	R. Gonzales Sprain	Twisted back while walking through chocks
5/30/75 8R	R. Gonzales Sprain	Twisted back while walking through chocks
6/2/75 8R	F. Munden Smashed Finger	Chock fell on finger
6/2/75 8R	J. Beandette Bruise	Rock fell on foot
6/20/75 8R	M. Gonzales Bruises	Mantrip scooter hit another scooter
6/25/75 4N	J. Maynard Sprain	Slipped onto stage loader 2DAYS LOST TIME

6/27/75 8R	F. Tapia Strain	Strained back while building cribs
7/1/75 4N	J. Jiron Bruise	Smashed finger while unloading crib blocks
7/1/75 4N	T. Sena Bruise	Coal from shearer hit him on head
7/1/75 8R	A. Pais Bruise	Chock leg slipped & hit right ankle
7/2/75 8R	F. Tapia Strain	Strained back building crib
7/3/75 4N	G. Martinez Bruises	Duke fell & hit him on shoulder
7/7/75 8R	D. Aguilar Strain	Pulled muscle taking up belt slack
7/8/75 8R	R. Gilbert Bruises	Slipped at headgate drive
7/8/75 8R	M. Margioukla Bruise	Cushman pedal stuck & hit his right leg
7/11/79 8R	R. Newman Bruises	Pinched hip between shearer & chock
8/7/75 8R	A. Grano Bruises	Rock fell from roof hitting left side of back
8/11/75 8R	J. Madrid Bruises	Falling rock struck wrist while advancing chock
8/14/75 4N	T. Ritz Strain	Holding chain when coal hit chain pulling arm
8/19/75 8R	D. Giacomo Bruises	Slipped into face conveyor and was drug 5 DAYS LOST TIME
8/21/75 8R	E. Lannon Bruises	Duke fell knocking him against beam
8/27/75 4N	S. Gallegos Lacerations	Rib fell & hit man on head
8/27/75 4N	T. Sena Lacerations	Coal fell from roof hitting him on head
9/4/75 8R	S. Perkins Sprain	Hit head on I beam & twisted neck
9/10/75 8R	R. Gonzales Strain	Pulled muscle lifting duke
9/11/75 8R	R. Gilbert Bruise	Coal fell from face hitting left foot

9/12/75 8R	J. Martinez Bruises	Water hose broke off shearer hitting him
9/23/75 8R	R. Montoya Bruises	Hit wrist against shearer
9/23/75 8R	P. Pintor Bruises	Rock from canopy fell on left foot
10/2/75 8R	C. Trujillo Strain	Lifting chain intensifier
10/6/75 3R	J. Butch Cut	Cutting brass with chisel and got brass chip in hand
10/6/75 8R	H. Moore Bruises	Winch cable broke & hit him
10/6/75 4N	F. Fernandez Strain	Strained lower back carrying welder
10/10/75 8R	G. Arguello Bruises	Belt cable broke & hit him
10/14/75 4N	J. Medina Bruises	Shearer drum kicked lock over guard & hit him
10/14/75 8R	A. Chavez Bruises	Duke fell pinching hand against conveyor
10/22/75 8R	J. Martinez Bruises	Rock fell between chocks hitting man's back
10/28/75 4N	L. Sisneros Strain	Pulled muscle lifting duke
10/28/75 4N	L. Ashbaugh Bruise	Rock struck him off shearer
10/30/75 4N	L. Gilbert Bruises	Dropped chunk of coal on foot
11/6/75 8R	F. Munden Puncture Wound	Stepped on nail in board
11/17/75 8R	T. Gonzales Bruises	Duke fell hitting shoulder & hand
11/19/75 8R	H. Moore Bruises	Caught right index finger in spill pan
11/20/75 4N	J. Escalante Bruises	Hit hand with sledge hammer
11/24/75 4N	A. Leatherman Bruises	Caught foot between push ram & spill pan

11/26/75 8R	J. Madrid Bruises	Rock fell from roof hitting his back
12/3/75 8R	A. Grano Bruises	Hose coupling flew apart & hit his right ankle
12/17/75 4N	E. Flores Bruises	Haulage chain pushed him into shields
1/6/76 4N	J. Garcia Amputation right thumb distal joint 4 DAYS LOST TIME	Caught thumb in jack cover on shield leg
1/21/76 4N	W. Morris Strain	Strained groin carrying welder
2/9/76 4N	S. Gallegos Bruises	Caught toes between push ram & conveyor
2/12/76 5L	H. Moore Bruises	Knocked into stage loader by a piece of coal
2/21/76 5L	R. Lemons Eye Scratched	Piece of coal in eye
3/1/76 5L	R. Lemons Bruise	Rock fell between chocks & hit his finger
3/4/76 5L	R. Gonzales Bruises	Rock fell between chocks & hit his back
3/8/76 5L	F. Tapia Cut	Fell while walking in conveyor & cut hand
3/8/76 4N	T. Gonzales Strain	Twisted neck while pulling shield lever
3/9/76 5L	F. Duran Bruise	Rock fell between chocks & hit his back
3/16/76 4N	C. Green Strain	Pulled neck muscle in horseplay
3/17/76 5L Sprain	J. Madrid Sprain	Slipped on rock & twisted left knee
3/17/76 4N	B. Butt Strain	Strained back lifting oxygen tank
3/27/76 4N	A. Leatherman Eye	Coal dust in eye
3/29/76 4N	J. Moore Strain	Strained back lifting duke
3/29/76 4N	A. Leatherman Bruises	Fell while stepping over chunk breaker

3/31/76 4N	C. Green Bruise	Caught foot between push ram & conveyor
4/7/76 5L	M. Rodman Cut	Cut finger while sawing timber
4/7/76 5L	C. Trujillo Bruise	Slipped & fell in chocks & bumped knee
4/15/76 5L	M. Cordova Bruise	Slipped and fell in chocks & bumped knee
4/20/76 5L	R. Montoya Cut	Rock fell between chocks & struck him
4/21/76 5L	W. Romero Bruises	Rock fell between chocks & hit him
4/27/76 4N	S. Gallegos Strain	Pulled muscle lifting wooden plank
4/28/76 5L	R. Montoya Eye	Coal chip from shearer got in his eye
4/28/76 4N	A. Leatherman Eye	Coal dust in eye from conveyor motor
4/30/76 5L	R. Porter Bruises	Comealong chain slipped & hit his back
5/10/76 4N	C. Espinoza Strain	Strained back lifting 5 gallon oil can
6/1/76 5L	E. Lannon Fractured rib	Cap rock from face struck him 3 DAYS LOST TIME
6/3/76 5L	J. Gourdin Strain	Strained lower back lifting duke
6/7/76 4N	A. Chavez Sprain	Twisted knee getting off battery scoop car
6/7/76 4N	M. Margioukla Strain	Strained right shoulder lifting duke
6/7/76 5L	F. Fernandez Bruise	Caught right little finger between shearer & chocks
6/10/76 5L	F. Fernandez Eye	Coal chip from shearer in eye

6/18/76 4N	W. Morris Bruise	Fell against rock stopper & hit chest
6/23/76 5L	J. Chavez Bruised Knee	Slipped and fell while walking down face
6/25/76 4N	S. Lewis Bruise	Pinched finger with crib block
7/20/76 5L	C. Gonzales Bruise	Rock fell between chocks & hit left shoulder
7/20/76 4N	S. Gallegos Strain	Strained arm pulling drill steel out of floor
7/23/76 5L	C. Gonzales Bruise	Rock fell on mantrip & hit left shoulder
7/29/76 5L	F. Duran Bruises	Rock fell between chocks & hit neck
8/2/76 5L	J. Cordova Bruise	Rock fell between chocks & hit back
8/3/76 5L	L. Gilbert Bruises	Rock fell between chocks & hit back
8/11/76 5L	A. Jaramillo Bruise	Rock fell between chocks & hit right knee
8/13/76 5L	C. Gonzales Bruise	Dropped steel mat on foot
8/13/76 5N	J. Bizyak Cut	Steel chip flew off bearing & cut left hand
8/19/76 5N	M. Martinez Bruise	Rock fell on right wrist
8/25/76 5L	F. Fernandez Bruise	Rock from shearer hit neck
8/30/76 5N	M. Johnson Bruise	Hit knee with sledge hammer
9/1/76 5N	C. Espinoza Cut	Cut left leg with knife while cutting belt
9/9/76 5L	G. Martinez Bruise	Roof fell between chocks & hit left hand
9/10/76 5N	P. Martinez Bruise	Rock fell & hit left leg

9/14/76 5L	J. Cordova Bruise	Rock fell between chocks & hit his left arm
9/14/76 5L	J. Gourdin Bruise	Pressure hose stripped threads & hit his neck
9/20/76 5L	A. Pagnotta Bruise	Rock fell between chocks and hit his right leg
9/23/76 5L	R. Usery Bruise	Rock fell between chocks & hit his back
9/23/76 5L	G. Carroll Bruise	Rock fell between chocks & hit left knee
9/29/76 5N	M. Margioukla Fracture	Rock from shearer hit finger LOST TIME
10/1/76 5L	M. Tafoya Eye	Chip in the eye from hammer and chisel
10/4/76 5N	D. Espinoza Strain	Slipped while crossing the belt
10/4/76 5N	C. Green Bruise	Rock fell & hit his right index finger
10/4/76 5L	R. Gonzales Eye	Coal from shearer flew into his eye
10/13/76 5L	J. Gage Bruise	Rock fell between chocks & hit his left foot
10/18/76 5L	A. Pagnotta Sprain	Duke fell over & sprained his neck 2 DAYS LOST TIME
10/20/76 5N	D. Starkovich Bruise	Rib sloughed off & hit her back
10/29/76 5N	A. Romero Dizziness	Rock fell & hit his head
11/1/76 5N	A. Romero Bruise	Rock fell & hit his left hand
11/2/76 5N	R. Arguello Bruises	Duke fell & hit his chest
11/2/76 5N	C. Green Fracture	Caught left hand between push ram & pans LOST TIME
11/4/76 5L	J. Cacciatore Sprain	Slipped on conveyor pan line & twisted back

11/11/76 5N	D. Gallegos Bruises	Rock fell in front of shields
11/11/76 5N	M. Johnson Bruise	Hit left foot with pick
11/17/76 5N	B. Butt Bruise	Dropped I beam on right foot
12/21/76 5N	J. Baca Cut	Rock fell on his left hand
1/5/77 5L	W. Snachez Bruise	Belt cable clamp broke & hit his knee
1/6/77 5N	L. Baca Sprain	Slipped & twisted knee while tramming shearer
1/10/77 5L	P. Pintor Bruise	Caught foot under push ram while pushing pan
1/10/77 5N	J. Cortez Bruise	Pinched finger while handling DA ram
1/26/77 5N	D. Ortega Bruise	Duke fell & hit his head
2/3/77 5N	C. Gilbert Strain	Strained back moving I beam
2/10/77 5N	C. Gonzales Bruise	Pinched finger handling I beam
2/28/77 5L	E. Lannon Cracked Tooth	Haulage chain hit him in the teeth
3/7/77 5N	H. Martinez Bruise	Rock fell off conveyor & hit his right leg
3/8/77 5L	F. King Cut & Fracture	Rock fell of belt & hit his right thumb
3/9/77 5L	M. Rodman Bruise	Hit his thumb with crib block
3/21/77 4N	H. Martinez Bruise	Duke fell on his right thumb
3/22/77 5N	R. Volpato Bruise	Caught hand between shearer drum & shield canopy
4/4/77 5N	S. Lewis Bruise	Chain hook slipped & hit his left leg
4/6/77 5N	J. Cortez Bruise	Dropped box of bits on left foot

4/11/77 5N	H. Trujillo Strain	Bumped into pull cord box on belt
4/14/77 5N	D. Gallegos Bruise	Rib fell on right foot
4/18/77 5L	S. Perkins Bruise	Rock fell between chocks & hit his left arm
4/29/77 5N	M. Johnson Strain	Strained back lifting hydraulic jack
5/2/77 5L	A. Chavez Bruise	Rock fell between chocks & hit his left foot
5/3/77 5L	B. Valverde Burn	Hot rubber from splice boot got in his right eye
5/9/77 5N	M Johnson Bruises	Hoist slipped & I beams knocked him over
5/16/77 5L	J. Martinez Bruise	Rock from shearer hit his right hip
5/18/77 5L	M. Rodman Bruises	Rock fell between chocks & hit his left hand
5/19/77 5L	J. Martinez Bruise	Rock from shearer hit his right elbow
5/24/77 5N move	C. Espinoza Cut	Cut finger cleaning drill steel
5/24/77 5N move	A. Leatherman Strain	Strained back moving oxygen tank
5/26/77 5N move	C. Espinoza Sprain	Slipped & sprained ankle in haulage entry
6/2/77 5L	J. Gourdin Bruise	Rock fell between chocks & hit his right shoulder
6/9/77 5N move	F. Ortega Bruise	Wooden prop fell on his back
6/17/77 5N move	B. Butt Fracture	Lowering hinge point & crushed wrist LOST TIME
6/17/77 5N move	A. Leatherman Strain	Slipped in mud straining back
6/21/77 5L	A. Chavez Strain	Strained back lifting rock

7/1/77 5N move	T. Gonzales Sprain	Elkhorn bounced in entry, bumped his head
7/21/77 5N move	D. Wakefield Bruise	Hit hand on shearing drum
8/15/77 5L move	R. Gonzales Scratch	Scratched finger on wire cable
8/22/77 5L move	M. Manfredi Strain	Slipped & fell in mud
8/23/77 5L move	B. Cruz Bruise	Pry bar slipped & hit him on neck
8/29/77 6N	D. Gallegos Bruise	Haulage chain hit his hand
8/31/77 6N	M. Johnson Strain	Bumped his head on duke
9/1/77 5L move	E. Lannon Pinch	Pinched finger between spill pans
9/6/77 5L move	L. Rea Sprain	Twisted neck
9/8/77 5N move	D. Starkovich Bruise	Slipped & fell & hit her chest
9/15/77 6N	R. Fernandez Bruise	Dropped air pick on his foot
9/19/77 6N	C. Espinoza Laceration	Hit by piece of coal from conveyor
9/20/77 6N	M. Nelson Eye	Foreign object in left eye
9/23/77 6N	T. Mitchell Bruise	Rock fell from roof, hand on spillplate
9/27/77 6L	J. Gourdin Bruise	Pry bar slipped & hit his hand
10/4/77 6L	F. Munden Laceration	Cut thumb with knife
10/5/77 6N	S. Montoya Sprain	Sprained wrist lifting chunk of coal
10/17/77 6L	E. Salas Bruise	Duke fell & hit his shoulder
10/19/77 6L	M. Johnson Sprain	Tripped & sprained his ankle

10/25/77 6N	G. Trujillo Bruise	Rock fell between shields
10/31/77 6N	A. Leatherman Bruise	Belt hanger plate fell on his foot
11/1/77 6N	A. Romero Bruise	Rib fell on his ankle
11/1/77 6N	D. Starkovich Bruise	Caught shovel on belt roller
11/7/77 6L	L. Rea Bruise	Rock fell from roof
11/9/77 6N	A. Romero Eye	Foreign object in eye
11/10/77 6N	J. Baca Hairline fracture LOST TIME	Haulage chain struck left leg
11/12/77 6N	L. Padilla Bruise	Coal fell from conveyor & hit his foot
11/18/77 6N	T. Gonzales Broken finger	Rock fell from roof
12/1/77 6N	J. Madrid Bruise	Haulage chain hit his left hip
12/3/77 6N	L. Gonzales Bruises	Rib fell & hit his arm
3/28/78 6N	J. Ortiz Bruise	Rock fell from roof & hit his foot
4/11/78 6N	T. Sciacca Bruise	Rock over shields fell & hit his knee
4/14/78 6N	L. Mestas Hairline crack	Shovel caught in belt & hit his wrist
5/5/78 6N	L. Ashbaugh Bruise	Hit knuckle while handling ram
5/11/78 6N	D. Stone Strain	Strained muscle shovelling belt
6/5/78 6L	G. Decker Bruise	Rock from shields hit his finger
6/20/78 6N	S. Montoya Sprain	Tripped on DA Ram, sprained ankle

6/22/78 6N	C. Gilbert Bruise	Rib fell against his knees
6/23/78 6M	S. Powroznik Scratch on eye	Piece of metal from stoper in eye
7/5/78 6N	M. Rodman Bruise	Rock from shield hit his head
7/10/78 6N	T. Ulibarri Sprain	Tripped & sprained ankle
7/11/78 6N	D. Quartieri Bruise	Rock from shield hit his shoulder 7 DAYS LOST TIME
7/11/78 6N	H. Martinez Bruise	Rock from shield hit right arm
7/24/78 6N	R. Edwards Cut	Removing belt, chain hit his thumb
7/25/78 6L	T. Ulibarri Eye	Cleaning belt, foreign object in eye
8/1/78 6N	L. Gonzales Cut	Rock from shields hit his left hand
8/17/78 6N	H. Martinez Bruise	Haulage chain threw rock and hit his shoulder
8/23/78 6L	J. Garcia Bruise	Rock from shields hit his leg
8/24/78 6L	R. Ortega Bruise	Prop fell & hit his shoulder
8/29/78 6L	E. Kyles Bruise	Rock from shields hit his leg
8/30/78 6N	L. Gonzales Bruise	Roof rock hit his right little toe
9/1/78 6N	D. Quartieri Bruise	Pinched thumb in jackhammer
9/18/78 6N	T. Ulibarri Strain	Strained back carrying props
9/22/78 6N	E. Kyles Sprain	Slipped & twisted knee on shield base
9/25/78 6N	F. Chavez Cut	Rock from jackleg hit his finger
9/27/78 6N	S. Wick Strain	Strained back lifting can of resin

APPENDIX 4

ACCIDENT FREQUENCY TABLES

Accident frequency is computed for each calendar year. Accident frequency is recomputed beginning January 1 of each year and each month's figures are year to date figures using lost time accidents per million man hours worked.

MONTH	SHIELD CHOCK OR MOVE S, C, M	ACCIDENTS	LOST TIMES	FATALITIES	TOTAL MAN HOURS	LOST TIME ACCIDENT FREQUENCY	TOTAL MINE LOST TIME ACCIDENT FREQUENCY	COMMENTS
5/75	S	3	0	0	3088	0	10.2	Frequency is computed with total man hours for entire year to date
	C	9	0	0	5216	0		
6/75	S	1	1	0	5144	121.5	16.8	
	C	4	0	0	5232	0		
7/75	S	3	0	0	2128	96.5	15.7	
	C	6	0	0	1920	0		
8/75	S	3	0	0	5384	63.5	15.9	
	C	4	1	0	4920	57.8		
9/75	S	0	0	0	4256	50	14.3	
	C	6	0	0	3600	49.4		
10/75	S	5	0	0	5368	39.4	14.5	
	C	6	0	0	4624	40.19		
11/75	S	2	0	0	4493	33.47	15.2	
	M	4	0	0	631	39.20		Move
12/75	S	1	0	0	4568	29.09	14.1	
	M	1	0	0	0	39.20		Move
1/76	S	2	1	0	4864	205.59	18.3	
	C	0	0	0	496	0		Move
2/76	S	1	0	0	3488	119.74	19.6	
	C	2	0	0	3216	0		
3/76	S	7	0	0	4872	75.62	24.8	
	C	5	0	0	4904	0		
4/76	S	2	0	0	4256	57.21	22.9	
	C	7	0	0	4248	0		
5/76	S	1	0	0	1855	51.72	25.7	Move
	C	0	0	0	5008	0	0	
6/76	M	4	0	0	0	51.72	30.6	
	C	5	1	0	4640	44.42		
7/76	S	1	0	0	2144	46.56	27.72	Move
	C	#	0	0	2440	40.08		
8/76	S	3	0	0	5360	37.26	28.39	
	C	5	0	0	5640	32.69		
9/76	S	3	1	0	5744	61.38	26.66	
	C	6	0	0	5880	27.42		
10/76	S	4	0	0	3712	55.10	28.12	
	C	4	1	0	3152	50.47		

MONTH	SHIELD CHOCK OR MOVE S, C, M	ACCIDENTS	LOST TIMES	FATALITIES	TOTAL MAN HOURS	LOST TIME ACCIDENT FREQUENCY	TOTAL MINE LOST TIME ACCIDENT FREQUENCY	COMMENTS
11/76	S	6	1	0	3312	83.58	27.67	
	C	1	0	0	3056	46.86		
12/76	S	1	0	0	3264	76.61	25.86	
	C	0	0	0	2920	43.86		
1/77	S	3	0	0	3784	0	44.8	
	C	2	0	0	3362	0		
2/77	S	2	0	0	3696	0	22.3	
	C	1	1	0	3352	148.94		
3/77	S	3	0	0	4752	0	20.6	
	C	2	1	0	4552	177.53		
4/77	S	5	0	0	4840	0	24.3	
	C	1	0	0	4544	126.50		
5/77	M	4	0	0	5112	0	22.2	Move
	C	5	0	0	5160	95.37		
6/77	M	3	1	0	3952	38.26	21.6	Move
	C	2	0	0	4240	79.33		
7/77	M	2	0	0	3176	34.12	19.0	Move
	C	0	0	0	3448	69.79		
8/77	S	2	0	0	6069	28.26	15.9	
	M	3	0	0	4864	59.66		Move
9/77	6N	5	0	0	5552	24.43	15.8	
	6L	3	0	0	4456	52.66		Move part of month
10/77	6N	3	0	0	6016	21.30	15.5	
	6L	3	0	0	6200	45.27		
11/77	6N	6	1	0	5600	38.06	15.3	
	6L	1	0	0	5912	39.93		
12/77	6N	2	0	0	968	37.37	15.0	Strike 12/5 - 3/27
	6L	0	0	0	1040	39.11		
3/78	6N	1	0	0	1368	0	0	
	6L	0	0	0	1336	0		
4/78	6N	2	0	0	5568	0		
	6L	0	0	0	5328	0		
5/78	6N	2	0	0	5544	0		
	6L	0	0	0	4360	0		

MONTH	SHIELD CHOCK OR MOVE S, C, M	ACCIDENTS	LOST TIMES	FATALITIES	TOTAL MAN HOURS	LOST TIME ACCIDENT FREQUENCY	TOTAL MINE LOST TIME ACCIDENT FREQUENCY	COMMENTS
6/78	6N	3	0	0	6296	0	4.55	
	6L	1	0	0	4160	0		
7/78	6N	5	1	0	5888	40.12	7.56	
	6L	1	0	0	1384	0		
8/78	6N	3	0	0	7240	32.45	5.95	
	6L	3	0	0	5560	0		
9/78	6N	5	0	0	6152	26.28	5.04	
	6L	0	0	0	4416	0		

APPENDIX 5

DAILY PRODUCTION FOR ALL

LONGWALLS FROM 4/75-9/78

Daily production figures are estimated raw tonnages based on average height of coal seam x length of face x number of shears for each shift x 2.5 feet of advance per shear. This figure is multiplied by a conversion factor of .04 tons per cubic foot of coal. These figures may vary from the monthly surveyed tonnages because of differences in surveying and daily estimates. The figures, however, do compare closely.

DAILY PRODUCTION May 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	13	551	14	1096	12							Chock face = 670'
2	13	895	14	643	12							
3	-	929	12	643	10							
4	---	---	---	---	---							
5	13	652	13	1080	13							
6	11	284	11	548	13							
7	8	422	13	844	13							
8	8	309	10	561	12							
9	8	422	12	762	9		7	480	11	480	11	First coal from the Shields
10	---	---	---	---	---	---	---	---	---	---	---	
11	---	---	---	---	---	---	---	---	---	---	---	
12	7	412	10	854	13		8	567	11	406	10	
13	8	378	12	595	13		8	847	11	712	11	
14	8	633	12	737	10		7	930	10	916	10	
15	7	517	11	353	11		8	480	11	480	11	
16	7	589	9	488	11		7	960	11	960	7	
17	---	---	---	---	---	---	---	---	---	---	---	
18	---	---	---	---	---	---	---	---	---	---	---	
19	7	428	11	740	12		8	480	11	934	10	
20	7	347	11	129	12		8	533	10	384	10	
21	8	447	12	454	10		8	978	11	---	10	
22	7	510	12	491	11		8	960	10	1013	11	
23	8	743	12	580	8		7	960	11	642	10	
24	---	---	---	---	---	---	---	---	---	---	---	
25	---	---	---	---	---	---	---	---	---	---	---	
26	---	---	---	---	---	---	---	---	---	---	---	Holiday
27	---	---	---	---	---	---	---	---	---	---	---	Funeral
28	7	422	10	400	11		7	371	10	781	10	
29	5	422	14	844	11		6	1484	8	651	9	
30	6	845	11	410	13		6	1441	8	1139	10	
31	---	---	---	---	---	---	---	---	---	---	---	Holiday

DAILY PRODUCTION June 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												
2	7	940	11	1134	12		6	638	10	966	9	
3	7	464	12	724	10		7	882	10	1189	9	
4	8	645	12	456	11		7	439	9	794	11	
5	9	362	13	524	11		8	878	10	722	12	
6	9	1085	13	939	11		8	718	10	846	12	
7												
8												
9	8	386	12	494	12		8	375	11	678	12	
10	9	724	12	999	12		10	1293	11	263	12	
11	8	459	12	362	10		10	786	11	878	12	
12	8	724	11	953	12		11	1057	11	1149	12	
13	9	661	12	1085	11		11	614	10	678	12	
14												
15												
16	9	564	9	902	12		9	607	10	40	12	
17	8	362	10	940	11		11	555	8	950	12	
18	8	858	11	940	11		11	116	10	1197	12	
19	8	724	11	686	11		11	877	10	1217	12	
20	9	54	11	---	12		11	1001	10	415	11	
21												
22												
23	8	1034	12	1085	11		9	196	8	890	13	
24	9	805	12	1153	12		10	879	10	878	12	
25	9	1035	12	1085	10		10	1073	10	1516	12	
26	9	362	12	605	11		10	878	11	1317	14	
27	9	362	11	524	11		9	1756	11	1536	10	
28												
29												
30	8	362	11	---	12		8	439	15	1001	10	
31												

DAILY PRODUCTION July 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	9	328	11	328	13		8	1278	15	1181	11	
2	9	---	11	657	13		9	788	15	1181	11	
3	8	929	9	426	12		8	1192	14	1325	10	
4	---	---	---	---	---	---	---	---	---	---	---	Holiday
5	---	---	---	---	---	---	---	---	---	---	---	
6	---	---	---	---	---	---	---	---	---	---	---	
7	9	328	10	681	12		8	608	15	1292	10	
8	8	681	11	985	13		10	1153	14	996	10	
9	8	502	12	172	13		8	601	15	1066	10	
10	9	462	11	372	12		10	924	15	609	10	
11	9	282	8	---	--		10	906	15	412	5	
12												
13												
14												
15								VACATION				
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												

DAILY PRODUCTION August 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												
2												
3												
4	8	985	10	853	10		10	1418	14	437	11	
5	9	465	10	656	13		10	1181	14	788	11	
6	9	1083	10	985	11		10	1292	13	1292	11	
7	9	914	10	---	12		10	787	14	1013	11	
8	9	147	10	328	11		10	1575	13	1024	11	
9												
10												
11	7	657	10	1083	13		9	1139	14	1196	12	
12	13	---	12	637	13		9	1496	14	1013	12	
13	13	688	12	701	14		11	405	13	1045	12	
14	7	299	12	985	13		11	730	12	902	11	
15	8	929	12	174	13		12	788	14	1121	12	
16												
17												
18	6	159	11	---	12		8	705	12	433	12	
19	7	279	11	715	12		9	777	13	451	13	
20	7	833	13	833	13		9	834	13	397	12	
21	7	853	12	657	11		8	587	10	1128	12	
22	6	816	13	985	8		6	963	12	788	11	
23												
24												
25	7	380	11	730	10		9	644	10	319	13	
26	7	882	10	328	11		9	179	11	429	13	
27	7	328	12	784	10		9	1038	11	967	12	
28	7	779	12	1441	11		9	788	10	351	13	
29	6	1348	12	54	11		8	107	11	276	12	
30												
31												

DAILY PRODUCTION September 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	----	----	----	----	----	----	----	----	----	----	----	Hōliday
2	8	328	12	755	11		9	632	13	655	13	
3	8	894	12	901	8		8	816	11	788	12	
4	9	657	10	936	9		9	340	10	1067	13	
5	9	809	10	985	10		10	601	11	1006	13	
6	----	----	----	----	----	----	----	----	----	----	----	
7	----	----	----	----	----	----	----	----	----	----	----	
8	9	816	10	840	10		10	587	11	1181	10	
9	9	1171	10	936	10		10	408	11	379	13	
10	9	985	10	985	9		10	591	11	100	13	
11	9	656	11	715	9		8	909	11	1182	14	
12	7	1262	8	657	10		8	838	12	1135	13	
13	----	----	----	----	----	----	----	----	----	----	----	
14	----	----	----	----	----	----	----	----	----	----	----	
15	----	----	----	----	----	----	----	----	----	----	----	Mine idle
16	----	----	----	----	----	----	----	----	----	----	----	Mine idle
17	----	----	----	----	----	----	----	----	----	----	----	Mine idle
18	----	----	----	----	----	----	----	----	----	----	----	Mine idle
19	----	----	----	----	----	----	----	----	----	----	----	Mine idle
20	----	----	----	----	----	----	----	----	----	----	----	
21	----	----	----	----	----	----	----	----	----	----	----	
22	7	657	9	439	9		9	863	13	924	11	
23	8	984	12	59	7		10	863	13	924	11	
24	9	706	11	267	9		10	1231	13	788	11	
25	9	657	11	620	9		10	14	11	995	11	
26	9	475	11	1156	9		9	902	11	787	11	
27	----	----	----	----	----	----	----	----	----	----	----	
28	----	----	----	----	----	----	----	----	----	----	----	
29	8	184	10	644	9		10	1002	11	1181	12	
30	9	972	10	1007	9		10	968	12	1318	12	
31												

DAILY PRODUCTION October 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	9	985	12	796	9		10	1214	11	813	12	
2	9	534	12	1132	9		10	1260	11	322	12	
3	9	586	10	---	6		9	1181	12	1002	10	
4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
6	9	---	11	88	8		9	1164	12	788	10	
7	8	328	12	328	7		9	1063	12	924	11	
8	9	1083	12	657	9		9	1575	11	1146	11	
9	8	402	11	985	8		8	1629	12	1231	11	
10	6	656	11	---	6		10	1146	12	---	11	
11	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
12	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
13	8	816	10	906	9		9	1181	11	1367	11	
14	11	603	11	576	8		8	741	12	720	11	
15	8	98	12	889	9		12	1575	11	788	12	
16	8	875	12	706	11		10	1403	10	186	12	
17	8	1036	12	730	7		10	1969	10	1324	10	
18	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
19	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
20	8	901	8	745	10		9	773	13	1862	10	
21	8	951	8	804	8		8	1837	13	1310	11	
22	7	1313	9	877	10		8	1024	13	820	13	
23	8	1103	9	779	9		10	948	11	1045	14	
24	7	985	10	1642	10		9	838	13	1121	12	
25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
26	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
27	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	Holiday
28	7	1156	10	984	11		10	852	11	1102	11	
29	8	1152	10	723	11		9	949	10	1182	11	
30	8	1313	9	1083	11		8	787	11	1138	11	
31	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	

DAILY PRODUCTION November 1975

	8 RIGHT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	---	---	---	---	---	---	---	---	---	---	---	
2	---	---	---	---	---	---	---	---	---	---	---	
3	5	1313	9	328	10		6	1267	13	1683	11	
4	8	657	10	328	9		9	1038	12	1374	12	
5	8	985	9	500	10		9	1092	13	1235	12	8 RIGHT COMPLETED
6							9	430	13	362	11	(First Chock Face)
7							9	698	13	927	10	
8						---	---	---	---	---	---	
9						---	---	---	---	---	---	
10						---	---	---	---	---	---	Mine idle
11						---	---	---	---	---	---	Mine idle
12						---	---	---	---	---	---	Mine idle
13						---	---	---	---	---	---	Mine idle
14						---	---	---	---	---	---	Mine idle
15						---	---	---	---	---	---	
16						---	---	---	---	---	---	
17							7	1403	13	1479	12	
18							8	823	13	1536	11	
19							11	68	13	1128	12	
20							7	1099	13	1460	11	
21							8	1181	8	1020	12	
22						---	---	---	---	---	---	
23						---	---	---	---	---	---	
24							7	1182	13	1181	11	
25							8	788	12	1181	11	
26							7	1232	12	1181	12	
27						---	---	---	---	---	---	Holiday
28						---	---	---	---	---	---	Mine idle
29						---	---	---	---	---	---	
30						---	---	---	---	---	---	
31												

DAILY PRODUCTION December 1975

	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1							7	444	12	237	13	
2							8	215	12	763	13	
3							8	544	12	1131	16	
4							9	312	11	967	14	
5							8	884	12	541	15	
6							---	---	---	---	---	
7							---	---	---	---	---	
8							8	709	12	787	13	
9							8	1181	12	469	13	
10							8	1576	12	788	13	
11							8	1181	12	995	16	
12							8	1575	12	927	12	
13							---	---	---	---	---	
14							---	---	---	---	---	
15							8	1325	12	1020	13	
16							8	143	12	795	12	
17							8	1181	12	1575	12	
18							8	1386	12	1325	12	
19							7	1181	12	1332	12	
20							---	---	---	---	---	
21							---	---	---	---	---	
22							10	848	15	1425	12	
23							10	1539	15	1232	12	
24							---	---	---	---	---	Holiday
25							---	---	---	---	---	Holiday
26							---	---	---	---	---	Mine idle
27							---	---	---	---	---	
28							---	---	---	---	---	
29							---	---	---	---	---	Mine idle
30							---	---	---	---	---	Mine idle
31							---	---	---	---	---	Mine idle

DAILY PRODUCTION January 1976

	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1							---	---	---	---	---	Holiday
2							---	---	---	---	---	Mine idle
3							---	---	---	---	---	
4							---	---	---	---	---	
5							6	394	13	1232	12	
6							9	788	13	1027	12	
7							---	---	---	---	---	Main belt broke
8							---	---	---	---	---	Main belt broke
9							9	788	13	788	12	
10							---	---	---	---	---	
11							---	---	---	---	---	
12							9	809	12	1189	12	
13							9	988	13	1010	12	
14							9	1181	13	1181	12	
15							9	788	13	1010	12	
16							9	1575	11	1231	10	
17							---	---	---	---	---	
18							---	---	---	---	---	
19							7	1575	14	1231	12	
20							9	1181	13	1790	13	
21							9	537	13	1575	14	
22							8	1504	12	1181	14	
23							5	1199	13	1232	16	
24							---	---	---	---	---	
25							---	---	---	---	---	
26							7	1325	13	1282	13	
27							8	1511	12	859	14	
28	10	---	11	500	11		7	1794	12	1275	14	5 Left started
29	8	355	11	180	11		8	1575	12	1181	14	
30	--	278	11	---	--		8	372	11	---	--	Main belt broke
31	---	---	---	---	---		---	---	---	---	---	Main belt broke

DAILY PRODUCTION February 1976

SHIFT	1	2	2	3	3	1	1	2	2	3	3	
	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	-----					-----						
2	7	---	11	640	10		8	942	11	508	13	
3	8	896	12	781	11		7	1221	12	286	14	
4	8	1224	12	428	9		7	1453	12	1504	14	
5	8	739	11	859	11		7	931	9	254	7	
6	8	1368	11	896	10		7	1253	12	1555	13	
7	-----					-----						
8	-----					-----						
9	7	821	10	153	11		5	1335	10	695	15	
10	8	1181	11	737	10		8	1590	11	512	14	
11	8	1440	12	786	10		6	838	12	1042	14	
12	8	1152	11	1152	10		4	1654	12	981	11	
13	6	1037	10	691	11		6	1056	11	877	13	
14	-----					-----						
15	-----					-----						
16	7	1151	10	864	11		5	1206	10	1085	14	
17	8	850	10	---	--		6	1232	12	---	--	Main belt broke
18	--	---	--	325	11	---	--	---	--	394	15	
19	8	1152	9	864	11		7	841	11	1138	14	
20	7	469	9	968	11		4	1378	11	831	15	
21	-----					-----						
22	-----					-----						
23	-----					-----						Mine idle
24	-----					-----						Mine idle
25	-----					-----						Mine idle
26	-----					-----						Mine idle
27	-----					-----						Mine idle
28	-----					-----						
29	-----					-----						
30												
31												

DAILY PRODUCTION March 1976

	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	8	980	14	1124	10		6	1117	13	541	11	
2	8	112	14	521	11		8	---	15	---	6	
3	8	770	15	592	11		8	---	13	---	9	
4	8	1120	13	1260	12		7	---	13	---	7	
5	----	----	----	----	----	----	----	----	----	----	----	Mine idle
6	----	----	----	----	----	----	----	----	----	----	----	
7	----	----	----	----	----	----	----	----	----	----	----	
8	7	770	12	700	8		7	279	11	50	10	
9	7	770	14	595	10		7	---	7	72	9	
10	7	805	11	577	9		7	1110	13	970	11	
11	8	490	11	227	10		7	788	13	1468	9	
12	8	823	11	1120	9		10	1198	15	1188	10	
13	----	----	----	----	----	----	----	----	----	----	----	
14	----	----	----	----	----	----	----	----	----	----	----	
15	7	630	12	770	9		8	920	13	1138	10	
16	8	980	11	987	9		10	1002	11	788	11	
17	9	700	14	763	9		10	846	11	1439	10	
18	9	1050	12	1355	10		9	974	11	1461	11	
19	----	----	----	----	----	----	----	----	----	----	----	Mine idle
20	----	----	----	----	----	----	----	----	----	----	----	
21	----	----	----	----	----	----	----	----	----	----	----	
22	8	745	14	1470	9		10	755	11	1156	10	
23	8	1120	14	1260	10		11	788	10	1224	10	
24	8	760	14	1470	11		11	340	11	1038	11	
25	8	1270	12	1050	11		9	898	11	1192	11	
26	----	----	----	----	----	----	----	----	----	----	----	Mine idle
27	----	----	----	----	----	----	----	----	----	----	----	
28	----	----	----	----	----	----	----	----	----	----	----	
29	8	822	10	927	13		0	598	11	766	10	
30	8	1050	11	1288	13		10	1181	12	1181	12	
31	8	942	11	1267	11		10	956	11	1253	11	

DAILY PRODUCTION   April 1976

	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	----------					----------						Holiday
2	----------					----------						Mine idle
3	----------					----------						
4	----------					----------						
5	8	300	10	900	11		6	1282	8	788	10	
6	8	900	10	990	12		9	14	10	788	11	
7	8	1116	11	1200	12		10	1575	11	444	10	
8	7	1200	10	1200	14		11	229	9	---	6	
9	----------					----------						Mine idle
10	----------					----------						
11	----------					----------						
12	12	300	10	1200	10		6	---	12	644	11	
13	8	1005	10	1200	10		9	283	11	---	11	
14	8	1200	10	1095	10		10	974	0	788	8	
15	7	1050	10	1338	9		10	1024	11	394	11	
16	----------					----------						Mine idle
17	----------					----------						
18	----------					----------						
19	8	900	10	1200	10		6	637	11	770	10	
20	8	1110	9	456	11		10	895	11	1013	11	
21	8	1167	10	1155	11		10	644	10	838	11	
22	7	1020	11	990	10		11	737	10	787	11	
23	8	690	10	900	10		11	573	10	226	11	
24	----------					----------						
25	----------					----------						
26	8	1500	12	900	9		9	394	11	759	10	
27	10	810	12	930	10		9	444	11	555	10	
28	8	1260	13	900	10		11	197	11	72	10	
29	8	1500	13	1746	11		10	329	9	143	10	
30	8	1554	12	1500	10		8	258	10	---	7	
31												

DAILY PRODUCTION May 1976

	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	---	---	---	---	---	---	---	---	---	---	---	
2	---	---	---	---	---	---	---	---	---	---	---	
3	8	1080	12	1320	10		10	358	7	233	8	
4	7	1500	12	1200	11		11	322	8	344	8	
5	8	1890	11	1200	11		11	204	9	254	8	
6	8	2004	14	1200	11		6	369	8	215	8	
7	7	1380	12	1400	11		8	247	8	344	6	
8	---	---	---	---	---	---	---	---	---	---	---	
9	---	---	---	---	---	---	---	---	---	---	---	
10	5	1350	12	1200	11		10	243	7	307	3	
11	8	1350	12	1401	11		8	301	9	161	8	
12	7	1500	13	1119	10		10	473	6	14	7	
13	8	1800	12	600	11		11	64	7	82	8	
14	12	1200	12	750	13		7	369	7	---	7	4 North completed
15	---	---	---	---	---							
16	---	---	---	---	---							
17	6	1500	12	1200	11							
18	8	1050	14	600	10							
19	9	480	14	1320	12							
20	8	900	12	900	11							
21	8	1350	12	750	12							
22	---	---	---	---	---							
23	---	---	---	---	---							
24	8	1005	11	1314	10							
25	7	1200	13	690	12							
26	7	1110	14	1026	12							
27	7	531	13	630	12							
28	7	900	13	810	10							
29	---	---	---	---	---							
30	---	---	---	---	---							
31	---	---	---	---	---							Holiday

DAILY PRODUCTION June 1976

	5 LEFT					4 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	8	981	11	1050	12		8		8		9	Moving
2	8	1041	11	1110	10		8		11		7	
3	8	1278	11	1200	10		9		9		8	
4	8	1110	11	1100	10		9		11		9	
5	----	----	----	----	----	----	----	----	----	----	----	
6	----	----	----	----	----	----	----	----	----	----	----	
7	7	780	12	318	10		8		9		8	
8	8	756	12	750	10		9		5		9	
9	8	843	12	855	10		9		8		9	
10	8	705	11	720	9		9		7		8	
11	8	780	11	480	8		9		8		4	
12	----	----	----	----	----	----	----	----	----	----	----	
13	----	----	----	----	----	----	----	----	----	----	----	
14	8	420	11	600	12		6		7		10	
15	7	660	12	540	12		8		9		11	
16	8	600	11	600	13		8		8		12	
17	8	900	14	1290	12		8		8		11	
18	8	210	12	900	11		7		8		9	
19	----	----	----	----	----	----	----	----	----	----	----	
20	----	----	----	----	----	----	----	----	----	----	----	
21	7	900	16	6[illegible]0	11		7		9		9	
22	8	765	13	900	11		8		9		10	
23	8	594	14	402	11		7		12		8	
24	8	363	14	450	11		8		11		9	
25	4	498	12	300	11		6		8		8	
26	----	----	----	----	----	----	----	----	----	----	----	
27	----	----	----	----	----	----	----	----	----	----	----	
28	----	----	----	----	----	----	----	----	----	----	----	Vacation
29	----	----	----	----	----	----	----	----	----	----	----	
30	----	----	----	----	----	----	----	----	----	----	----	
31	----	----	----	----	----	----	----	----	----	----	----	

DAILY PRODUCTION July 1976

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												Vacation
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19	8	900	14	600	10		9		12		10	
20	7	600	14	1320	10		6		12		10	
21	8	261	13	960	10		7		12		11	
22	8	630	14	918	10		8		12		11	
23	8	780	13	633	10		7		13		10	
24												
25												
26	7	600	12	564	9		8		10		8	
27	8	348	14	300	10		8		13		11	
28	7	300	13	540	9		6		12		11	
29	8	300	13	300	9		8		12		11	
30	8	390	12	333	9		8		12	320	11	
31												

DAILY PRODUCTION August 1976

	5 LEFT					5 NORTH							
	CHOCK FACE					SHIELD FACE							COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3		
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN		
1													
2	7	129	11	600	11		8	495	10	1010	12		
3	7	600	13	900	10		8	755	13	1425	11		
4	8	900	12	810	10		7	0	11	0	12		
5	7	699	13	300	10		3	860	13	1180	12		
6	7	600	13	735	10		8	1090	11	1230	12		
7													
8													
9	5	765	11	420	11		7	1080	11	1080	8		
10	7	300	11	390	12		7	490	11	1335	9		
11	8	420	11	300	14		8	530	13	1510	9		
12	8	900	11	600	12		6	1720	12	1720	9		
13	8	900	11	900	12		9	1290	13	860	8		
14													
15													
16	9	900	11	780	11		9	1510	12	1290	10		
17	10	810	12	705	14		9	1290	11	1550	11		
18	10	450	11	762	13		8	660	10	1470	10		
19	10	600	10	564	12		8	1895	9	1280	10		
20	10	702	11	690	10		5	1290	11	1750	11		
21													
22													
23	9	660	11	612	12		9	1050	11	230	13		
24	11	738	12	78	13		7	2190	12	1180	13		
25	11	684	11	438	13		8	1290	12	1230	13		
26	11	840	11	825	12		8	430	12	2130	13		
27	11	600	11	540	11		9	945	12	0	12		
28													
29													
30	11	720	10	600	13		7	1390	11	1605	14		
31	11	900	10	780	15		8	1000	15	500	14		

ILY PRODUCTION September 1976

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
IFT	1	2	2	3	3	1	1	2	2	3	3	
TE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	10	694	10	582	15		7	948	13	1097	13	
2	11	510	10	326	14		10	1658	14	876	13	
3	10	0	9	0	13		7	803	12	1730	12	
4	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
5	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
6	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
7	11	416	12	604	12		8	578	10	1381	13	
8	10	255	12	574	10		9	986	11	969	12	
9	11	510	13	765	11		9	1394	11	1462	11	
10	10	612	13	602	10		10	1097	11	1097	10	
11	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
12	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
13	11	765	10	793	12		9	914	11	1301	12	
14	12	510	13	829	12		9	555	15	1475	11	
15	12	765	11	510	13		9	1237	15	808	12	
16	11	571	13	905	13		9	1352	15	859	11	
17	12	859	12	383	11		9	1496	13	638	11	
18	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
19	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
20	11	510	9	510	11		8	493	12	782	11	
21	11	637	13	637	12		8	1105	14	1096	13	
22	10	313	13	637	10		7	731	15	1355	13	
23	11	663	13	688	12		9	901	14	947	12	
24	10	357	10	510	12		9	1304	13	1041	12	
25	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
26	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	
27	10	663	12	459	12		12	816	13	705	13	
28	10	255	12	306	13		13	731	13	663	11	
29	9	441	12	332	12		13	365	14	705	11	
30	10	446	12	408	12		12	1097	13	366	12	
31												

DAILY PRODUCTION October 1976

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	10	283	10	306	11		13	859	10	761	10	
2	---	---	---	---	---	---	---	---	---	---	---	
3	---	---	---	---	---	---	---	---	---	---	---	
4	9	344	10	434	11		12	234	10	969	15	
5	9	255	11	281	13		10	1165	10	778	13	
6	8	204	13	---	--		12	365	12	---	--	
7	---	---	---	---	---	---	---	---	---	---	---	
8	---	---	---	---	---	---	---	---	---	---	---	
9	---	---	---	---	---	---	---	---	---	---	---	
10	---	---	---	---	---	---	---	---	---	---	---	
11	8	153	12	357	10		11	1462	13	1475	15	
12	8	383	12	255	12		11	1802	13	1462	15	
13	9	383	13	382	10		11	1309	12	1666	13	
14	6	255	11	433	11		12	1564	13	1759	14	
15	---	---	---	---	---	---	---	---	---	---	---	
16	---	---	---	---	---	---	---	---	---	---	---	
17	---	---	---	---	---	---	---	---	---	---	---	
18	9	255	11	383	11		11	1287	13	1675	15	
19	9	382	11	433	12		12	986	13	1526	13	
20	8	331	11	255	12		11	1900	13	1096	15	
21	7	382	11	306	12		10	1827	13	2287	13	
22	9	332	11	204	13		9	1462	12	1462	11	
23	---	---	---	---	---	---	---	---	---	---	---	
24	---	---	---	---	---	---	---	---	---	---	---	
25	---	---	---	---	---	---	---	---	---	---	---	MINE IDLE
26	---	---	---	---	---	---	---	---	---	---	---	
27	---	---	---	---	---	---	---	---	---	---	---	
28	---	---	---	---	---	---	---	---	---	---	---	
29	---	---	---	---	---	---	---	---	---	---	---	
30	---	---	---	---	---	---	---	---	---	---	---	
31	---	---	---	---	---	---	---	---	---	---	---	

DAILY PRODUCTION November 1976

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	8	191	10	140	10			1386	11	1373	10	
2	7	383	10	225	12		9	914	11	2117	11	
3	7	382	11	383	11		9	1547	10	1997	9	
4	7	383	11	446	12		8	1207	11	1556	10	
5	---	---	---	---	---	---	---	---	---	---	---	
6	---	---	---	---	---	---	---	---	---	---	---	
7	---	---	---	---	---	---	---	---	---	---	---	
8	7	255	13	255	13		9	1674	12	1713	10	
9	8	382	13	326	9		10	2036	13	1827	9	
10	10	332	13	357	9		9	1096	12	1760	10	
11	8	332	13	255	[illegible]		10	1819	13	1543	9	
12	---	---	---	---	---	---	---	---	---	---	---	
13	---	---	---	---	---	---	---	---	---	---	---	
14	---	---	---	---	---	---	---	---	---	---	---	
15	7	383	11	510	9		8	876	12	1352	10	
16	6	510	11	454	9		8	1364	11	1207	11	
17	5	510	11	255	10		8	1224	11	1250	11	
18	5	836	13	1020	11		6	578	11	621	10	
19	---	---	---	---	---	---	---	---	---	---	---	
20	---	---	---	---	---	---	---	---	---	---	---	
21	---	---	---	---	---	---	---	---	---	---	---	MINE IDLE
22	---	---	---	---	---	---	---	---	---	---	---	
23	---	---	---	---	---	---	---	---	---	---	---	
24	---	---	---	---	---	---	---	---	---	---	---	
25	---	---	---	---	---	---	---	---	---	---	---	
26	---	---	---	---	---	---	---	---	---	---	---	
27	---	---	---	---	---	---	---	---	---	---	---	
28	---	---	---	---	---	---	---	---	---	---	---	
29	7	306	11	456	11		[illegible]	---	11	366	10	
30	6	344	11	255	11		9	1097	13	1360	11	
31												

DAILY PRODUCTION December 1976

	5 LEFT CHOCK FACE					5 NORTH SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	6	382	11	296	11		9	846	13	1666	13	
2	6	357	12	255	10		9	901	13	1096	11	
3												
4												
5												
6	7	383	12	306	12		9	795	13	876	11	
7	7	331	12	357	12		9	561	11	1568	11	
8	7	510	12	273	12		9	1015	12	1351	11	
9	7	383	10	---	--		9	820	11	859	11	
10												
11												
12												
13	7	---	--	255	12		7	1216	11	1632	12	
14	7	434	10	380	11		9	1840	10	837	12	
15	7	194	12	242	11		9	1352	11	803	9	
16	7	331	13	255	11		8	1109	10	965	10	
17												
18												
19												
20	7	382	11	321	12		8	1139	11	187	12	
21	7	214	[illegible]	---	12		9	1097	11	1097	12	
22	7	255	12	268	10		9	1202	11	1020	12	
23												
24												
25												
26												
27												
28												
29												
30												
31												

DAILY PRODUCTION January 1977

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	----	----	----	----	----	----	----	----	----	----	----	
2	----	----	----	----	----	----	----	----	----	----	----	
3	7	510	11	191	11		8	1006	9	1026	12	
4	6	332	13	255	12		9	983	12	717	12	
5	6	255	13	255	12		9	866	11	1318	12	
6	6	344	12	255	12		9	737	11	1615	12	
7	----	----	----	----	----	----	----	----	----	----	----	
8	----	----	----	----	----	----	----	----	----	----	----	
9	----	----	----	----	----	----	----	----	----	----	----	
10	7	510	11	255	9		8	780	11	702	9	
11	6	255	13	255	9		9	1030	12	959	10	
12	6	255	12	255	10		9	1045	12	944	10	
13	6	438	10	332	10		9	694	12	1018	11	
14	----	----	----	----	----	----	----	----	----	----	----	
15	----	----	----	----	----	----	----	----	----	----	----	
16	----	----	----	----	----	----	----	----	----	----	----	
17	7	64	10	257	11		8	1084	11	807	11	
18	7	344	10	408	12		9	335	11	1139	11	
19	----	----	----	----	----	----	----	----	----	----	----	
20	----	----	----	----	----	----	----	----	----	----	----	
21	----	----	----	----	----	----	----	----	----	----	----	
22	----	----	----	----	----	----	----	----	----	----	----	
23	----	----	----	----	----	----	----	----	----	----	----	
24	8	446	10	319	10		9	1006	12	1006	11	
25	7	357	10	408	11		9	870	11	1096	11	
26	7	255	10	306	10		9	741	10	117	11	
27	5	434	10	255	9		11	1155	9	714	11	
28	----	----	----	----	----	----	----	----	----	----	----	
29	----	----	----	----	----	----	----	----	----	----	----	
30	----	----	----	----	----	----	----	----	----	----	----	
31	7	316	10	255	10		9	1006	12	893	9	

DAILY PRODUCTION February 1977

	5 LEFT					5 NORTH						COMMENTS
	CHOCK FACE					SHIELD FACE						
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	7	255	10	293	9		9	850	11	1049	11	
2	7	510	10	408	9		8	1342	11	1045	11	
3	7	255	10	510	10		9	971	12	1006	11	
4	--------					--------						
5	--------					--------						
6	--------					--------						
7	7	280	9	---	11		9	788	10	1240	12	
8	7	332	10	408	12		8	686	10	886	12	
9	7	357	11	306	12		9	1127	9	601	10	
10	7	561	9	388	11		7	923	9	1123	11	
11	--------					--------						
12	--------					--------						
13	--------					--------						
14	6	765	11	510	10		9	827	11	866	11	
15	7	510	12	382	11		9	1162	13	1256	11	
16	7	332	11	207	10		9	1303	12	920	10	
17	7	510	11	260	11		9	1380	12	1061	11	
18	--------					--------						
19	--------					--------						
20	--------					--------						
21	7	433	11	107	11		9	1342	12	288	10	
22	7	---	11	306	9		8	1146	13	1190	9	
23	7	765	11	168	10		10	1084	11	1006	9	
24	6	510	12	344	11		12	1006	12	1342	11	
25	--------					--------						
26	--------					--------						
27	--------					--------						
28	--------					--------						
29												
30												
31												

DAILY PRODUCTION   March 1977

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	7	765	12	---	11		9	1006	12	1135	11	
2	7	---	6	---	9		9	975	13	944	10	
3	7	510	11	408	11		9	335	13	1166	10	
4	----	----	----	----	----	----	----	----	----	----	----	
5	----	----	----	----	----	----	----	----	----	----	----	
6	----	----	----	----	----	----	----	----	----	----	----	
7	7	510	10	510	9		10	1322	12	1240	10	
8	7	510	11	510	10		10	1677	12	1342	10	
9	8	510	11	510	10		9	325	12	725	9	
10	8	510	11	765	9		9	---	12	1061	9	
11	----	----	----	----	----	----	----	----	----	----	----	
12	----	----	----	----	----	----	----	----	----	----	----	
13	----	----	----	----	----	----	----	----	----	----	----	
14	6	612	11	665	8		10	1271	11	1123	10	
15	8	357	11	255	12		9	1045	10	1377	13	
16	8	510	11	510	11		8	827	10	1341	12	
17	8	510	11	510	11		8	429	10	---	10	
18	----	----	----	----	----	----	----	----	----	----	----	
19	----	----	----	----	----	----	----	----	----	----	----	
20	----	----	----	----	----	----	----	----	----	----	----	
21	8	510	11	638	11		8	889	10	1677	11	
22	7	765	11	510	11		6	823	10	1182	13	
23	8	893	11	1020	11		6	1342	10	156	12	
24	8	319	12	1403	12		8	905	10	1634	13	
25	8	765	11	---	--		8	55	10	---	--	
26	----	----	----	----	----	----	----	----	----	----	----	
27	----	----	----	----	----	----	----	----	----	----	----	
28	7	1020	9	1211	11		8	1006	10	1342	12	
29	7	1147	11	1020	12		8	1006	10	1268	12	
30	8	765	12	1020	12		8	1037	10	1677	12	
31	8	---	12	637	12		7	1343	10	1677	11	

DAILY PRODUCTION April 1977

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	------					------						
2	------					------						
3	------					------						
4	7	1020	10	1275	10		8	1342	12	860	10	
5	8	1148	11	982	12		9	1529	10	1498	13	
6	8	---	11	---	9		8	1123	10	1341	13	
7	6	---	11	---	9		8	1194	11	1104	12	
8	8	675	11	765	8		7	648	11	1107	10	
9	------					------						
10	------					------						
11	6	1275	11	612	8		8	1201	9	944	12	
12	8	1020	13	663	11		8	1420	12	1478	12	
13	7	765	13	892	12		8	1677	12	1552	13	
14	7	510	12	510	11		8	2031	10	1369	13	
15	7	---	5	765	12		8	1763	12	1677	12	
16	------					------						
17	------					------						
18	6	765	10	485	11		8	1342	13	1342	10	
19	7	510	10	---	--		7	374	11	---	--	Belt down
20	7	510	10	689	12		7	959	10	1342	12	
21	7	357	11	433	11		8	1100	13	1299	12	
22	7	663	13	944	8		7	1576	13	1290	10	
23	------					------						
24	------					------						
25	7	594	12	426	12		8	1291	12	2110	13	
26	8	1020	13	765	11		8	1107	12	86	12	
27	8	765	13	740	11		8	1634	11	1626	10	
28	8	791	13	892	11		7	807	11	842	12	
29	8	255	13	383	8		7	1318	12	2200	12	
30	------					------						
31	------					------						

DAILY PRODUCTION May 1977

	5 LEFT					5 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												
2	7	1020	12	1020	12		9	1342	11	1962	12	
3	8	969	13	561	10		9	382	12	---	12	
4	8	714	12	408	11		8	335	11	413	12	
5	7	255	13	765	12		9	293	12	39	12	
6	8	339	13	---	7		7	628	13	39	12	
7												
8												
9	7	842	10	765	12		9	491	10	246	11	
10	7	1275	13	1020	13		10	335	10	335	11	
11	7	765	12	1020	13		10	335	10	374	11	
12	7	97	12	459	13		10	628	10	374	11	
13	7	765	11	306	11		10		10		11	Moved shields
14												
15												
16	7	765	12	510	12		8		11		10	
17	7	408	12	357	12		10		12		11	
18	7	765	13	510	14		8		12		10	
19	7	255	14	893	13		10		15		10	
20												
21	7	765	12	318	11		8		12		8	
22												
23	5	765	10	638	11		9		10		10	
24	7	956	14	586	11		10		9		9	
25	7	688	14	510	11		10		11		10	
26	5	1020	14	765	11		9		11		10	
27	5	765	12	765	11		9		8		6	
28												
29												
30												
31	7	765	11	638	11		9		10		8	

DAILY PRODUCTION June 1977

	5 LEFT	CHOCK FACE				5 NORTH	SHIELD FACE					COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	7	510	12	1275	11		9		11		8	Shields Moved all month
2	6	1148	11	765	12		7		11		10	Belt broken
3	6	459	12	---	--		8		11		-	
4	---	---	---	---	---	---	---	---	---	---	---	
5	---	---	---	---	---	---	---	---	---	---	---	
6	8	765	12	1020	13		7		9		9	
7	8	561	13	867	13		9		11		12	
8	7	663	13	---	13		10		11		12	
9	6	714	13	1071	12		8		11		10	
10	7	1122	13	---	11		8		9		10	
11	---	---	---	---	---	---	---	---	---	---	---	
12	---	---	---	---	---	---	---	---	---	---	---	
13	8	1020	11	918	10		8		11		11	
14	8	1275	11	956	13		9		11		8	
15	8	1084	11	1020	12		9		8		10	
16	7	1097	12	689	11		9		12		9	
17	7	1454	12	765	11		8		10		8	
18	---	---	---	---	---	---	---	---	---	---	---	
19	---	---	---	---	---	---	---	---	---	---	---	
20	7	1530	12	1020	9		7		10		11	
21	8	993	12	1224	12		10		12		10	
22	8	1275	11	714	11		8		12		8	
23	7	1403	12	689	10		8		8		8	
24	7	1020	10	---	3		8		5		7	
25	---	---	---	---	---	---	---	---	---	---	---	
26	---	---	---	---	---	---	---	---	---	---	---	
27	---	---	---	---	---	---	---	---	---	---	---	
28	---	---	---	---	---	---	---	---	---	---	---	
29	---	---	---	---	---	---	---	---	---	---	---	
30	---	---	---	---	---	---	---	---	---	---	---	
31												

DAILY PRODUCTION July 1977

	5 LEFT					6 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	----------					----------						Mine Vacation
2	----------					----------						
3	----------					----------						
4	----------					----------						
5	----------					----------						
6	----------					----------						
7	----------					----------						
8	----------					----------						
9	----------					----------						
10	----------					----------						
11	7	893	11	893	11				10		8	Moving
12	9	638	12	1148	11		11		12		10	All
13	9	1275	13	1148	13		9		12		12	Month
14	10	1785	11	383	11		10		7		9	
15	10	510	12	1020	10		10		11		9	
16	----------					----------						
17	----------					----------						
18	9	1020	12	510	11		9		9		8	
19	9	128	13	1020	12		10		12		10	
20	9	128	12	765	12		9		12		13	
21	8	365	11	---	--		7		12		13	Main belt broke
22	----------					----------						Main belt broke
23	----------					----------						
24	----------					----------						
25	7	431	11	811	12		8		12		12	
26	7	510	12	854	13		11		14		--	
27	9	1071	12	880	12		10		--		11	
28	8	255	12	---	7		8		13		19	
29	7	---	12	510	12		8		--		7	
30	----------					----------						
31	----------					----------						

DAILY PRODUCTION August 1977

	5 LEFT					6 NORTH						
	CHOCK FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	4	510	10	---	12		12	---	13	---	12	Chock move
2	9		13		11		9	553	13	519	12	
3	9		12		10		9	553	12	1029	13	
4	9		9		10		14	650	11	148	11	
5	8		9		11		9	1309	13	319	12	
6												
7												
8	7		12		11		8	1122	13	1420	12	
9	8		12		11		9	489	11	1445	13	
10	8		11		11		9	1071	11	1615	13	
11	8		11		10		9	901	10	799	12	
12	9		10		5		8	1147	10	1785	13	
13												
14												
15	8		10		11		9	1445	11	1364	11	
16	9		9		13		8	850	12	1147	12	
17	8		9		13		10	1530	13	1309	12	
18	8		6		10		7	531	14	212	12	
19	8		5		7		9	1407	14	1275	11	
20												
21												
22	8		6		10		11	229	13	697	10	
23	8		7		10		10	1275	14	--	10	6N roof fall
24	5		7		12		11		13		11	
25	7		7		10		10	361	13	552	10	
26	7		7		5		10	1037	13	1275	10	
27												
28												
29	3		7		11		5	468	10	2040	11	
30	8		5		12		10	1147	13	1232	12	
31	7		4		11		8	612	13	595	10	

DAILY PRODUCTION September 1977

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	8		8		10		10	1148	13	1305	12	
2	3		8		5		9	1232	14	1275	12	
3												
4												
5												
6	8		7		8		8	1275	14	1360	13	
7	8		7		7		9	1721	12	1016	15	
8	8		5		7		9	1020	13	977	15	
9	8		5		7		9	510	13	1700	13	
10												
11												
12	9		10		11		9	1063	10	1819	13	
13	9		8		11		10	1062	11	1041	12	
14	9		8		11		10	1126	11	927	12	
15	9		8		9		9	808	12	680	11	
16	9		7		4		10	999	13	667	13	
17												
18												
19	7		8		11		10	1096	11	1109	13	
20	8		9		12		9	1857	12	1275	13	
21	9		9		12		9	1190	11	510	13	
22	9		10		12		8	1063	11	995	11	
23	9		10		11		9	705	11	--	10	
24												
25												
26	10		9		11		8	893	11	684	13	
27	9		10		11		8	1007	12	867	13	
28	10		11	123	11		8	850	10	357	11	
29	8	46	11	--	11		9	850	11	212	13	
30	10	217	10	700	10		8	213	10	468	9	
31												

DAILY PRODUCTION October 1977

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												
2												
3	7	734	11	528	13		7	850	11	1351	14	
4	10	733	10	542	17		9	803	11	1547	14	
5	10	367	11	339	16		9	944	9	1275	13	
6	10	301	12	297	17		8	1147	11	1058	12	
7	9	769	11	53	13		9	1220	10	1012	13	
8	9	465	11	84	15		8	1296	10	850	12	Working Saturdays
9												Until contract strike
10	10	1138	12	1254	12		9	850	13	1109	13	
11	10	1296	12	1332	12		10	1041	14	446	11	
12	10	643	12	1467	12		9	506	12	425	11	
13	10	1579	10	1642	12		12	221	12	--	10	
14	10	1021	13	1240	10		15	--	14	136	10	
15	8	867	12	1101	8		11	425	13	850	7	
16												
17	7	1013	12	1509	12		8	--	12	774	7	
18	7	767	12	1282	12		9	616	14	633	10	
19	7	1028	11	1100	12		8	850	14	654	11	
20	7	629	12	1832	12		8	795	13	722	11	
21	7	769	12	1800	9		8	1203	14	1190	11	
22	5	1261	12	---	3		4	552	9	655	11	
23												
24												
25	11	867	12	1006	13		10	1054	14	637	11	
26	10	1100	11	1275	13		8	1105	13	910	12	
27	10	993	12	1100	11		8	527	14	735	12	
28	10	367	11	1530	12		8	1131	13	722	13	
29	9	556	10	944	11		8	603	11	297	10	
30												
31	9	993	12	1834	13		10	501	13	693	12	

DAILY PRODUCTION November 1977

	6 LEFT SHIELD FACE					6 NORTH SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	11	1219	12	1293	11		10	557	12	425	10	
2	11	1171	12	1467	10		10	--	11	408	11	
3	11	996	11	1286	13		10	187	13	570	11	
4	10	923	12	1607	13		8	242	13	765	11	
5	9	598	10	647	10		8	850	10	1700	9	
6	----------					----------						
7	9	1495	131	1649	10		9	302	11	276	11	
8	11	552	13	1223	10		10	128	10	127	10	
9	8	1530	14	1289	12		7	--	11	179	9	
10	9	1656	14	1289	11		10	425	12	561	12	
11	9	2271	13	1782	11		8	680	11	238	11	
12	9	1607	12	1467	9		6	935	12	425	8	
13	----------					----------						
14	8	958	13	--	11		9	425	12	510	11	
15	10	367	13	1164	11		8	340	12	765	12	
16	10	1275	12	1502	11		8	425	11	--	12	
17	10	1525	13	1362	10		8	807	11	1105	12	
18	10	1362	11	1152	8		8	608	11	595	10	
19	7	779	9	1022	12		8	425	10	149	12	
20	----------					----------						
21	10	1022	13	1179	10		9	807	10	1173	13	
22	11	795	12	1441	11		9	774	11	--	13	
23	6	1476	13	1275	11		9	574	10	425	13	
24	----------					----------						
25	----------					----------						
26	----------					----------						
27	----------					----------						
28	10	746	12	1392	11		8	255	11	765	13	
29	11	1259	13	--	--		8	680	11	--	--	Main belt broke 3rd shift idle
30	9	1022	13	175	11		7	391	11	765	13	
31												

DAILY PRODUCTION December 1977

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	9	681	13	1197	11		8	646	11	672	13	
2	10	1327	12	1362	11		6	--	11	425	13	
3	9	1635	11	1285	11		8	824	11	612	11	
4	------	------	------	------	------	------	------	------	------	------	------	
5	10		11		12		8		10		12	Contract Strike 12/5--3/26/78
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												

ILY PRODUCTION January 1978

	6-LEFT					6-NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
IFT	1	2	2	3	3	1	1	2	2	3	3	
TE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14						MINE ON STRIKE						
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												

DAILY PRODUCTION February 1978

	6 LEFT SHIELD FACE					6-NORTH SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												
2												
3												
4												
5												
6												
7												
10												
11												
12												
13												
14												
15						MINE ON STRIKE						
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												

DAILY PRODUCTION March 1978

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1												Mine Strike to 3/26/78
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27	10	1768	11	1622	13		10	230	13	255	11	
28	10	1736	11	1395	11		10	553	13	531	12	
29	10	1525	11	1541	13		10	234	13	128	11	
30	10	1703	11	1362	13		10	425	13	816	11	
31	9	1622	11	1473	13		10	213	13	808	11	

DAILY PRODUCTION June 1978

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	8	1947	11	211	12	232	13	584	11	--	14	
2	8	--	1-	1022	11	320	11	800	11	976	12	
3	------	------	------	------	------	------	------	------	------	------	------	
4	------	------	------	------	------	------	------	------	------	------	------	
5	8	1362	10	--	11	260	11	400	11	800	13	
6	9	746	11	--	12	--	12	760	13	1012	15	
7	9	279	11	620	12	400	13	720	12	832	17	
8	9	681	11	681	13	720	13	960	10	1120	15	
9	8	681	11	1022	12	320	13	548	11	400	15	
10	------	------	------	------	------	------	------	------	------	------	------	
11	------	------	------	------	------	------	------	------	------	------	------	
12	9	681	11	681	13	292	10	1200	14	840	16	
13	9	681	12	681	12	440	13	800	14	1240	16	
14	9	681	11	681	12	--	13	728	13	188	15	
15	8	681	11	681	12	544	12	584	13	576	16	
16	7	1022	11	681	11	--	11	608	13	464	15	
17	------	------	------	------	------	------	------	------	------	------	------	
18	------	------	------	------	------	------	------	------	------	------	------	
19	9	681	12	681	12	--	10	608	14	564	15	
20	9	681	12	681	12	--	12	396	14	480	16	
21	9	681	12	681	10	320	12	460	14	400	14	
22	8	681	12	681	10	--	11	400	14	720	14	
23	8	681	10	681	10	52	10	540	12	320	9	
24	------	------	------	------	------	------	------	------	------	------	------	
25	------	------	------	------	------	------	------	------	------	------	------	
26	------	------	------	------	------	--	7	640	12	800	11	Mine vacation
27	------	------	------	------	------	--	7	--	12	520	10	Mine idle on 6 LEFT
28	------	------	------	------	------		7	400	9	800	10	
29	------	------	------	------	------	--	7	720	10	800	9	
30	------	------	------	------	------	--	8	880	10	760	10	
31												

DAILY PRODUCTION April 1978

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	----	----	----	----	----	----	----	----	----	----	----	
2	----	----	----	----	----	----	----	----	----	----	----	
3	10	1703	12	1736	12		9	300	12	60	11	
4	10	1557	12	1372	12		9	192	12	180	11	
5	9	1022	11	341	12		9	40	10	104	11	
6	9	--	--	1136	12		9	--	2	496	11	Belt down 2nd shift
7	9	1703	12	1525	12		10	312	12	96.	11	
8	9	1557	12	1362	14		10	596	12	144	11	
9	----	----	----	----	----	----	----	----	----	----	----	
10	9	1427	11	1655	13		10	632	12	200	11	
11	9	1476	11	1362	13		9	792	12	356	11	
12	9	1703	11	1492	13		9	260	12	844	11	
13	9	1577	11	1152	13		9	652	12	1024	11	
14	9	1362	11	1152	13		9	940	12	500	9	
15	----	----	----	----	----	----	----	----	----	----	----	
16	----	----	----	----	----	----	----	----	----	----	----	
17	9	1749	11	1249	13	220	11	860	12	1240	12	Started producing coal 1st shift
18	9	519	10	633	13	288	13	872	12	1000	14	
19	9	1525	11	681	13		12	1104	10	880	12	
20	9	1119	11	541	12	172	12	1520	11	1600	13	
21	8	260	10	513	12	440	12	88	11	1148	11	
22	----	----	----	----	----	----	----	----	----	----	----	
23	----	----	----	----	----	----	----	----	----	----	----	
24	8	532	12	902	10		11	572	12	1048	11	
25	8	1362	12	1334	10		12	--	12	748	12	
26	9	1197	12	1362	10		12	144	12	320	11	
27	9	1275	11	1979	11		12	560	12	744	12	
28	7	1362	12	1022	11	480	12	1104	12	1232	12	
29	----	----	----	----	----	----	----	----	----	----	----	
30	----	----	----	----	----	----	----	----	----	----	----	
31												

DAILY PRODUCTION July 1978

	6 LEFT					6 NORTH						COMMENTS
	SHIELD FACE					SHIELD FACE						
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	--	--	--	--	--	--	--	--	--	--	--	
2	--	--	--	--	--	--	--	--	--	--	--	
3	--	--	--	--	--		7	600	8	740	9	
4	--	--	--	--	--	--	--	--	--	--	--	
5	--	--	--	--	--	--	5	400	10	800	8	
6	--	--	--	--	--	--	7	952	12	960	10	
7	--	--	--	--	--	--	5	--	9	800	10	
8	--	--	--	--	--	--	--	--	--	--	--	
9	--	--	--	--	--	--	--	--	--	--	--	
10	--	--	--	--	--	--	8	400	12	560	19	
11	--	--	--	--	--	--	11	440	14	320	19	
12	--	--	--	--	--	--	11	320	15	400	19	
13	--	--	--	--	--	--	10	400	16	712	19	
14	--	--	--	--	--	--	9	80	15	400	18	
15	--	--	--	--	--	--	--	--	--	--	--	
16	--	--	--	--	--	--	--	--	--	--	--	
17						--	10	480	15	760	17	
18	--	--	--	--	--	--	9	500	15	40	17	
19	--	--	--	--	--	--	10	580	15	240	17	
20	--	--	--	--	--	--	11	400	15	312	16	
21	--	--	--	--	--	--	12	540	15	400	14	
22	--	--	--	--	--	--	--	--	--	--	--	
23	--	--	--	--	--	--	--	--	--	--	--	
24	9	1022	10	1022	10	--	11	472	13	416	13	
25	9	1022	9	1022	11	--	12	424	13	720	10	
26	9	1022	12	1022	10	--	12	544	15	850	11	
27	9	1022	10	1022	10	--	10	520	15	800	10	
28	9	1022	10	--	4	--	9	400	13	200	11	
29	--	--	--	--	--	--	--	--	--	--	--	
30	--	--	--	--	--	--	--	--	--	--	--	
31	9	1022	12	1022	11	--	9	400	13	200	11	

DAILY PRODUCTION August 1978

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	9	1022	12	1022	11	--	13	520	13	520	11	
2	4	1022	12	876	11	--	12	80	13	600	11	
3	9	341	9	1022	10	--	13	800	11	900	13	
4	9	824	10	701	9	--	12	80	11	400	12	
5												
6												
7	8	536	9	503	8	--	12	612	13	680	12	
8	9	293	10	438	11	--	13	672	13	80	12	
9	6	779	11	601	11	--	12	468	12	200	12	
10	9	286	11	536	11	--	14	--	12	--	12	Roof fall 6N
11	8	260	10	779	10	160	14	400	13	320	9	
12												
13												
14	7	513	13	633	11	--	11	520	15	600	12	
15	9	341	13	574	11	--	12	212	14	120	12	
16	9	172	13	516	11	--	13	412	15	880	12	
17	6	341	13	458	11	280	14	400	14	492	11	
18	7	182	13	341	9	--	13	400	12	300	12	
19												
20												
21	7	393	11	510	11	--	13	--	15	480	12	
22	8	513	12	614	11	200	14	400	14	600	12	
23	8	--	13	250	11	140	13	260	14	400	14	
24	8	341	11	681	11	--	13	120	14	--	12	Roof fall 6N
25	7	341	11	341	10	96	12	88	13	100	14	
26												
27												
28	7	302	12	909	12	--	10	--	14	320	12	Roof fall 6N
29	9	513	13	863	11	100	14	560	14	40	12	
30	9	853	14	850	12	--	13	--	15	--	11	Roof fall 6N
31	9	681	13	681	11	--	13	72	14	--	12	

DAILY PRODUCTION September 1978

	6 LEFT					6 NORTH						
	SHIELD FACE					SHIELD FACE						COMMENTS
SHIFT	1	2	2	3	3	1	1	2	2	3	3	
DATE	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	TONS	MEN	
1	9	681	8	681	11	--	15	120	13	280	11	
2	----	----	----	----	----	----	----	----	----	----	----	
3	----	----	----	----	----	----	----	----	----	----	----	
4	----	----	----	----	----	----	----	----	----	----	----	
5	7	681	13	681	11	292	13	--	14	672	11	
6	8	681	13	--	10	--	13	192	14	352	11	
7	3	681	12	--	11	--	13	--	14	--	12	Roof fall 6N, Scheduled down 6L
8	6	681	11	--	11	--	12	--	14	--	12	
9	----	----	----	----	----	----	----	----	----	----	----	
10	----	----	----	----	----	----	----	----	----	----	----	
11	8	681	12	--	11	--	13	152	14	--	12	
12	9	681	11	--	13	--	13	--	12	--	12	
13	9	341	10	--	12	--	13	--	11	--	12	
14	7	341	9	--	12	--	14	--	15	--	12	
15	8	503	9	--	11	11	14	--	13	--	9	
16	----	----	----	----	----	----	----	----	----	----	----	
17	----	----	----	----	----	----	----	----	----	----	----	
18	9		11	341	12	--	14	--	15	--	12	
19	9	341	11	--	13	--	13	352	15	--	12	
20	7	341	11	--	12	--	11	136	14	--	12	
21	8	--	11	341	11	--	12	80	13	--	12	
22	3	341	8	341	9	360	11	372	13	120	11	
23	----	----	----	----	----	----	----	----	----	----	----	
24	----	----	----	----	----	----	----	----	----	----	----	
25	--	341	11	341	13	--	10	112	14	160	12	
26	5	341	11	341	13	--	13	364	15	336	12	
27	4	341	10	341	13	--	13	368	14	360	13	
28	4	341	9	432	13	--	13	80	15	--	11	
29	--	340	7	--	--	--	11	--	12	--	--	Roof fall 6N Prepare to recover
30	----	----	----	----	----	--	18	--	10	--	--	roof shields
31												

APPENDIX 6

COMPARISON OF COSTS

The following tables have been prepared to compare the cost per ton of three three types of longwall shields. The chock longwall in 8th Right and 5th left, is compared in costs per ton to the shield longwall in 4 North and 5 North. The "G" type shields in 6th Left is also compared to the USBM shields in 6 North. The costs are compared in each one month period. For each period, the USBM shield longwall is arbitrarily given a cost of $100 per net ton of raw coal. In this way, the percentage of costs for the chocks can be given without giving actual costs per ton.

The following is a sample calculation:

For the month X the following information is given:

	Shield Longwall cost/ton	Chock Longwall cost/ton
Labor	$15.6	$14.2
Benefits & royalties	2.3	4.2
Salaries	2.1	3.3
Supplies & parts	.1	.4
Total	20.1	22.1

The shield longwall total is arbitrarily set to $100 per ton by multiplying the total 20.1 by 4.975. All other figures are then also multiplied by 4.975 to produce the following published figures:

	Shield Longwall cost/ton	Chock Longwall cost/ton
Labor	$77.61	$70.65
Bebefits & Royalites	11.44	20.89
Salaries	10.45	16.42
Supplies & parts	.50	1.99
Total	100.00	109.95

These figures are a percentage of the total shield longwall costs.

COSTS $ PER NET TON RAW COAL

MONTH		TOTAL LABOR	BENEFITS & ROYALTIES	SALARIES & BENEFITS	SUPPLIES & PARTS	TOTAL	COMMENTS
May 75	8R Chock	31.87	.02	7.75	51.38	91.00	
	4N Shield	41.66	.21	13.94	44.19	100.00	
June	8R Chock	80.65	.00	24.09	79.29	184.03	
	4N Shield	56.14	1.17	11.46	31.20	100.00	
July	8R Chock	62.18	.00	61.28	51.50	174.96	
	4N Shield	45.87	.39	20.50	33.28	100.00	
Aug	8R Chock	66.16	.00	23.87	43.73	159.04	
	4N Shield	68.30	.00	12.50	19.24	100.00	
Sept	8R Chock	48.07	.00	22.59	35.35	106.19	
	4N Shield	59.50	4.77	14.88	20.84	100.00	
Oct	8R Chock	62.94	28.63	10.81	32.64	135.02	
	4N Shield	58.00	.09	22.21	19.70	100.00	
Nov	8R Chock	374.88	5.32	233.45	151.61	765.26	Chock Move
	4N Shield	56.85	.86	17.65	24.60	100.00	
Dec	8R Chock						Chock move, no tonnage
	4N Shield	47.11	.48	15.55	36.89	100.00	
Jan 76	5L Chock	1936.31	3.19	743.19	-464.67	2217.98	Chock move
	4N Shield	70.52	-6.88	16.22	20.15	100.00	
Feb	5L Chock	63.62	4.84	27.31	29.56	125.32	
	4N Shield	58.96	.00	19.02	22.02	100.00	
March	5L Chock	62.19	.12	15.4	22.95	100.70	
	4N Shield	70.44	.04	23.14	6.34	100.00	
April	5L Chock	22.50	.96	6.96	10.54	40.96	
	4N Shield	50.16	.17	10.41	39.26	100.00	Shield face fault
May	5L Chock	6.70	.15	2.77	1.16	12.78	
	4N Shield	55.14	.94	25.40	18.51	100.00	Shield move & fault
June							Shield move, no data
July							Shield move, no data
Aug	5L Chock	108.96	32.10	32.29	78.96	252.26	
	5N Shield	61.08	9.21	19.34	10.38	100.00	
Sept	5L Chock	61.13	31.20	19.59	52.95	164.89	
	5N Shield	36/16	25.66	9.70	28.34	100.00	
Oct	5L Chock	112.15	70.23	50.77	64.81	322.16	
	5N Shield	29.88	28.95	11.74	28.82	100.00	
Nov	5L Chock	177.07	21.97	67.46	78.40	345.53	
	5N Shield	58.84	7.49	27.60	14.15	100.00	

COSTS $ PER NET TON RAW COAL

MONTH		TOTAL LABOR	BENEFITS & ROYALTIES	SALARIES & BENEFITS	SUPPLIES & PARTS	TOTAL	COMMENTS
Dec 76	5L Chock	120.06	14.60	58.93	146.15	343.33	
	5N Shield	50.32	6.32	16.16	27.17	100.00	
Jan 77	5L Chock	98.45	48.54	51.65	49.53	248.16	
	5N Shield	40.98	20.49	17.19	21.31	100.00	
Feb	5L Chock	110.98	54.13	52.33	75.87	293.26	
	5N Shield	43.07	21.45	17.68	17.80	100.00	
March	5L Chock	74.00	35.91	26.00	36.85	172.72	
	5N Shield	48.63	23.74	15.80	11.78	100.00	
April	5L Chock	71.89	35.02	26.42	43.60	176.95	
	5N Shield	36.63	17.68	12.26	33.48	100.00	
May	5L Chock	24.79	12.18	8.18	16.75	61.61	
	5N Shield	34.15	16.22	17.59	32.04	100.00	Move 5N to 6N
June							No figures, shield move
July							No figures, shield move
Aug	5L Chock						No figures, shield move
	6N Shield	37.32	17.81	10.35	34.52	100.00	
Sept	5L Chock	125.65	60.97	51.25	463.45	701.32	Move most of the month
	6N Shield	46.33	2.00	13.57	38.10	100.00	
Oct	6L Shield	56.13	23.20	14.64	22.79	102.05	
	6N Shield	48.43	20.23	12.49	18.85	100.00	
Nov	6L Chock	20.44	8.66	5.29	11.00	45.39	
	6N Shield	39.12	16.53	11.32	33.03	100.00	
Dec	6L Chock	6.56	2.47	10.32	5.23	24.58	Contract strike 12/5-3/26
	6N Shield	12.57	4.82	22.79	59.82	100.00	
March	6L Shield	6.80	3.27	7.96	-0.17	17.86	Part returned to warehouse
	6N Shield	31.48	15.13	35.75	16.65	100.00	
April	6L Shield	30.65	12.91	8.22	20.06	71.84	
	6N Shield	46.25	19.21	11.81	22.75	100.00	
May	6L Shield	40.38	18.02	13.62	49.97	121.97	Bought new gear box for face conveyor
	6N Shield	48.62	21.86	15.47	14.05	100.00	
June	6L Shield	42.59	19.32	19.12	22.37	103.50	Production restricted to 4 shears
	6N Shield	38.01	17.37	16.39	28.24	100.00	
July	6L Shield	32.99	14.83	29.95	6.05	83.82	Production restricted
	6N Shield	43.36	19.81	12.14	24.69	100.00	
Aug	6L Shield	27.81	12.59	7.70	19.01	67.11	
	6N Shield	45.14	20.62	11.43	22.82	100.00	
Sept	6L Shield	16.36	7.39	5.17	4.37	33.30	Production restricted
	6N Shield	44.45	20.08	13.79	21.68	100.00	Bad roof, low production

REFERENCES

Euler, W.J., 1978, "How to keep Your Longwall Working", Coal Age, April, p. 72 - 81.

Johnson, R.B., Dixon, G.H., and Wanck, A.A., 1966, "Late Cretaceous and Tertiary Stratigraphy of the Raton Basin of New Mexico and Colorado", in New Mexico Geological Society Guidebook, Taos - Raton - Spanish Peaks Country; 17th Field Conf., 1966, p. 89 - 98.

Merrit, P.C. and Davis, H., 19777, "Longwall Mining: Avenue to Safety, Productivity, and Resource Recovery", Coal Age, January, p. 59 - 107.

Pillmore, C.L., 1969, "Geology and Coal Deposits of the Raton Coal Field Colfax County, New Mexico", The Mountain Geologist, V. 6, No. 3, p. 125 - 142.

Von Eschen, G.F., 1961, "The Climate of New Mexico, Climatological Summaries for 35 Weather Stations and the State", Business Information Series, No. 37, Albuquerque, College of Business Administration, The University of New Mexico, p. 47.

Von der Linden, W., 1977, "Summary of Performance of Shield Type Supports in the U.S.", SME Transactions, June, p. 156 - 164.

Woodward, L.A., and Snyder, D.D., " Structural Framework of the Southern Raton Basin", New Mexico Geol. Soc. Guidebook, 27th Field Conf., May, p. 126.

Yi-Fu, Tuan, Everard, C.E., and Widdison, J.G., 1969, "Climate of New Mexico", Santa Fe, New Mexico, State Planning Office, p. 18 and 159, fig. 2.