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USBM CONTRACT NO. H0242028

**DESIGN AND DEVELOPMENT OF
PROTECTIVE CANOPIES FOR SHUTTLE
CAR, LOADER, AND ROOF DRILL**

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GUIDANCE SYSTEMS DIVISION
DENVER OPERATIONS**

USBM CONTRACT FINAL REPORT (Contract No. H0242028)

Bureau of Mines Open File Report 4-76

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Final Report

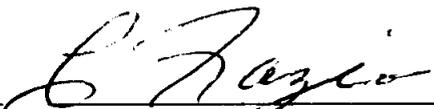
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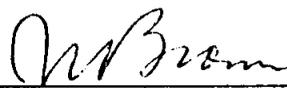
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"The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies of the Interior Department's Bureau of Mines or of the U.S. Government."

The Bendix Corporation
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FOREWORD

This final report was prepared by the Bendix Corporation, Navigation and Control Division of Denver, Colorado, under a U.S. Bureau of Mines (USBM) Contract No. H0242028. The contract was initiated under the Coal Mine Health and Safety Research program. It was administered under the technical direction of the Pittsburgh Mining and Safety Research Center, with Mr. J. C. Ault acting as Technical Project Officer. The objective of this program was to further refine and modify the three canopy designs, for a shuttle car, loader and roof drill, previously developed and conduct further testing and demonstration of the refined design.

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1. INTRODUCTION

This report, which covers the period from January 16 to October 21, 1974, describes the work performed in compliance with the requirements of contract no. H0242028 and modifications 1 and 2 thereto. The purpose of the contract was to further refine and modify three of the canopies (shuttle car, loader, and roof drill) which were developed under contract no. H0220031, and to conduct further testing and demonstration of the refined designs. Modifications 1 and 2 involved conducting further in-mine evaluations of the face drill and cutter canopies, also developed under contract no. H0220031.

In addition to the canopy modifications, the contract involved an evaluation of an operator's seat concept for a shuttle car which was developed for the USBM by another contractor.

2. SUMMARY

2.1 Shuttle Car Canopy Modification - One shuttle car canopy configuration was established in February, and preliminary designs were generated for the support structure and the machine-canopy interface attachments. Preliminary stress analysis was completed on the canopy and the support structure. A wooden mockup of this canopy was completed to be used at the demonstration mine to obtain machine operator assessment of vision, ingress and egress, etc.

In March, several other types of wooden mockups of canopy tops for the shuttle car were completed. These canopies retained the basic cantilevered concept but did depart from the flat plate design in that they were shaped and contoured in a manner believed to better withstand roofing, etc.

On March 11, 1974, the program was reviewed with the USBM and the canopy mockups were examined as installed on a mockup of the shuttle car operator's pit. It was determined that sufficient visual improvement was achieved to warrant evaluation in the mine.

The mine was visited on March 18-20, 1974, and the selected wooden canopy mockup was installed on the shuttle car and evaluated by the first-shift operator (6 ft 3 in. tall) and the second-shift operator (5 ft 7 in. tall). The evaluation was primarily for visual acceptability and ease of entry and exiting. This attempt to get onsite operator comments using the wooden mockup was well received and effective. The operators were of the opinion that the modified canopy does provide improved visual capability over the original canopies tested under contract no. H0220031. It was concluded that canopies constructed in accordance with the modified contoured top design, would be acceptable for testing in the mine. The operators believe some problems still exist in the low positions (approximately 32 to 38 inches overall height) but that in the 38- to 47-inch range, which is where they would be used in the 52-inch No. 12 mine, they would be acceptable.

In April, all detail drawings were completed for the selected shuttle car canopy. Also, a layout drawing was completed for installation of the standardized operator's seat in the 21SC shuttle car.

On April 18, 1974, all drawings and technical status of the program were reviewed with Mr. George Judy, the Program Technical Consultant. He considered that the progress made toward improved canopy configuration was quite satisfactory.

In May, effort was centered primarily on the standardized seat. All mounting brackets were designed and fabricated. The seat contour was changed and the fiberglass mockup was reinforced such that it could be used directly in the 21SC shuttle car installation, or as a pattern for a mold.

Also, in May, shockmounted equipment operator seats were examined and plans were formulated to lay out a shockmounted seat installation concept for the 21SC shuttle car, and secondly, to procure an off-the-shelf seat suspension system so that an in-mine evaluation could be obtained later in the program.

The shuttle car canopy height adjust hydraulic circuit was satisfactorily tested on the hydraulic system breadboard generated in the original low coal canopy program.

In June, the adaptation work was completed on the standardized seat. A mold was made from the recontoured seat, and new seats were fabricated. All mounting hardware was completed.

Work was also completed on a test fixture and loading arrangement: a hydraulic jack for applying a single point load to the cantilevered canopies and a pressure readout device. It was determined that the shock absorbing seat suspension was not feasible for the No. 12 mine. The suspension would add 6 inches to the seat height, which is not acceptable in that mine.

The initial canopy load test was completed on July 16 and final load testing was completed during the week of July 22, 1974.

During the week of August 5-8, the shuttle car canopy assembly along with standardized seats for the off-standard shuttle car were delivered to the No. 12 mine. The canopy support posts and the canopy hydraulic system were installed on the standard shuttle car. The hydraulics were not connected to the machine system at that time. The seats were installed in the second car.

Upon returning to the mine on August 27-30, one of the canopy support tubes was bent. This was corrected. Hydraulics were rerouted. All three canopy sections were installed on August 29. When returning to the mine on August 30 it was found that the rear canopy section had been roofed and bent back 15°. The three canopy sections were then removed. In addition, the seats were removed from the other shuttle car.

On September 17 the mine was revisited to repair the canopy. When examining the parts after arrival it was discovered that the left-hand support structure had again been bent. The support assembly was taken off the car and repaired at the mine machine shop.

The canopy center section was also removed and modified by the mine shop. This was done due to recommendations from the operators who objected to its size. It was made 12 inches narrower and the edges were rounded. Rock guards were added to keep clumps of coal from sliding into the operator.

On September 30, the shuttle car canopy sections and the repaired support structure were installed. The completed canopy was operationally demonstrated to the USBM on October 2.

2.2 Loader Canopy Modification - Revisions were made to the drawings for the loader canopy in April. Material was obtained, and fabrication of the modified hardware was completed in May. In-mine installation was performed in August.

The loader canopy installation had been in operation for approximately 14 months prior to modification and had sustained no additional damage other than that encountered initially with the hydraulic cylinder piston rods. The basic structure and method of attachment to the cat frame is proving to be sound.

The hydraulic posts on the loader canopy were removed on August 7 and replaced with manually adjustable posts. All hydraulic equipment associated with the canopy was also removed.

2.3 Roof Drill Canopy Modification - The demonstration mine (Jewell Ridge Coal Company No. 12 mine) was visited the week of February 11, 1974, and the roof drill canopy (contract no. H0220031) was removed from the machine in the Big Creek Tiller mine and was reinstalled on a roof drill in the No. 12 mine. Machine tramming tests were conducted without the flexible belt flooring installed and tramming was observed to be satisfactory. It was concluded that the "bulldozing" effect and unsatisfactory performance in the Big Creek Tiller mine was caused by the rigidity of the belt flooring being used, and that use of a lighter and more flexible floor material would solve the problem.

In March, the roof drill was again given tram testings with the canopy installed without the flexible flooring. The mobility of the machine did not appear to be impaired. Observations reinforced previous test results which indicated that the original belt flooring, due to rigidity when captured within the support

frame, was the main cause for the bulldozing and machine bog down encountered during mine testing. As a result of these tests it was decided to proceed with the roof drill canopy modification as proposed. A lighter weight belting material, previously procured in the program and on hand at the mine, was installed in the support frame and placed in operation for evaluation without the rest of the canopy structure installed. Initial results indicated acceptable operation.

In April, the Jewell Ridge Coal Company No. 12 mine was contacted with regard to the status of the roof drill flooring evaluation. The mine superintendent reported that the flooring and framework was still in use and proving to be acceptable enough to justify going ahead with the planned modifications and reinstallation of the canopy top and the roof jack.

During the trip to the mine on September 17-20, the roof drill hydraulic system was revised. On October 2, the canopy spacer, mechanical adjust tube, and canopy top were installed and the modified roof bolter canopy installation was demonstrated for USBM and MESA personnel.

2.4 Face Drill Canopy Installation - During the various visits to the mines, operation of the face drill with the canopy installed under contract no. H0220031 was observed to be functioning satisfactorily with no major problems, however, the mechanical downstops have been damaged and are not working. The hydraulic adjustment system is not operative due to the jammed stops. Neither of these failures are affecting present successful use of the canopy. The pump was removed for use elsewhere. The canopy is well received by the miners.

2.5 Cutter Canopy Installation - This canopy, also developed and installed under contract no. H0220031, was observed in operation during the various mine visits under this contract. It has functioned satisfactorily since it was installed and is acceptable to the miners. The same problem with jammed mechanical downstops has been experienced on the cutter, but is not affecting present use of the canopy since the adjustment capability is not required.

3. SHUTTLE CAR CANOPY MODIFICATION

3.1 Background - The shuttle car canopy developed under contract no. H0220031 is shown in figure 3-1. This canopy was unsatisfactory because the operators found visibility to be adversely affected, particularly in the off-standard car. This factor was common both to machine operators and mine management. The same feeling existed even with the canopies in the full 40-inch up position. Apparently, the tunnel effect of the long canopy top overhead caused a real visual obstruction as well as perhaps a psychological one.

3.2 New Concepts - One canopy modification proposed to improve operator vision is shown in figure 3-2. After that proposed configuration had been reexamined, it was concluded that a cantilevered configuration, such as shown in figure 3-3, would be better because it would eliminate visual blockage by a support structure directly in the operator's field of view. This configuration had been studied with respect to structural feasibility, and a preliminary stress analysis indicated that a 4 1/2- by 4 1/2- by 1/4-inch wall telescoping tube assembly and a 3/4-inch solid steel plate canopy would withstand the design load of 9,000 lb (based on 15 psi over approximately 600 sq in.). The weldment of the post to the plate canopy would also withstand the load. The hinged protective deck and mounting bracket designs were also found to be structurally adequate.

Shown in figure 3-4 is the square post assembly, two of which, will support each cantilevered canopy located at opposite ends of the operator's pit. The post assemblies are telescoping and are operated by internally mounted hydraulic cylinders. The stroke of these assemblies has been increased to 15 inches as opposed to the 8-inch-stroke cylinders used under contract no. H0220031. The longer stroke is considered to be a necessity in order to fully achieve the visual improvements desired and to more thoroughly evaluate a wider range of canopy heights. The demonstration mine accommodates a wider range of canopy height adjust than 0 to 8 inches.

Several additional concepts of canopy top shapes were generated in an attempt to arrive at a top better able to withstand roofing. The general idea was to arrive at some modification of a flat plate that would avoid the possibility of a leading edge hanging up on a roof bolt. Attempts were made to evaluate effects on operator vision due to different approaches such as placing shoes on the top of the flat canopy or by dishing the canopy.

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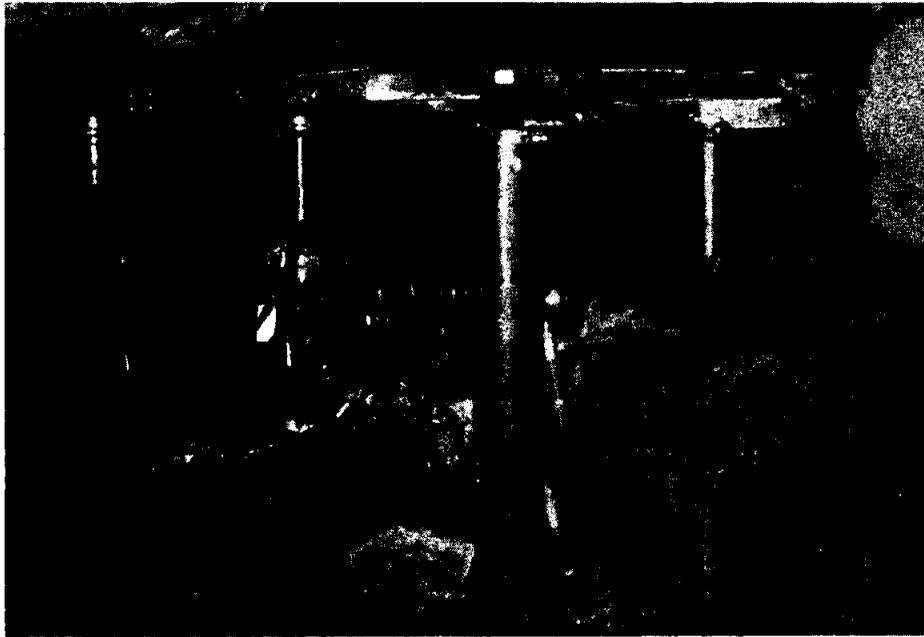


Figure 3-1. Original Protective Canopy

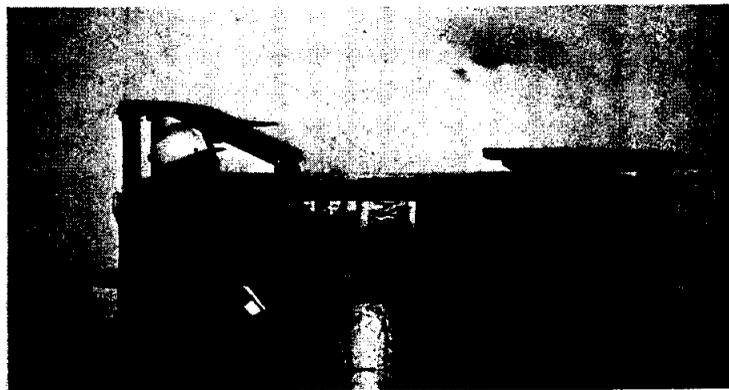


Figure 3-2. Proposed Canopy Modification



Figure 3-3. Cantilevered Canopy

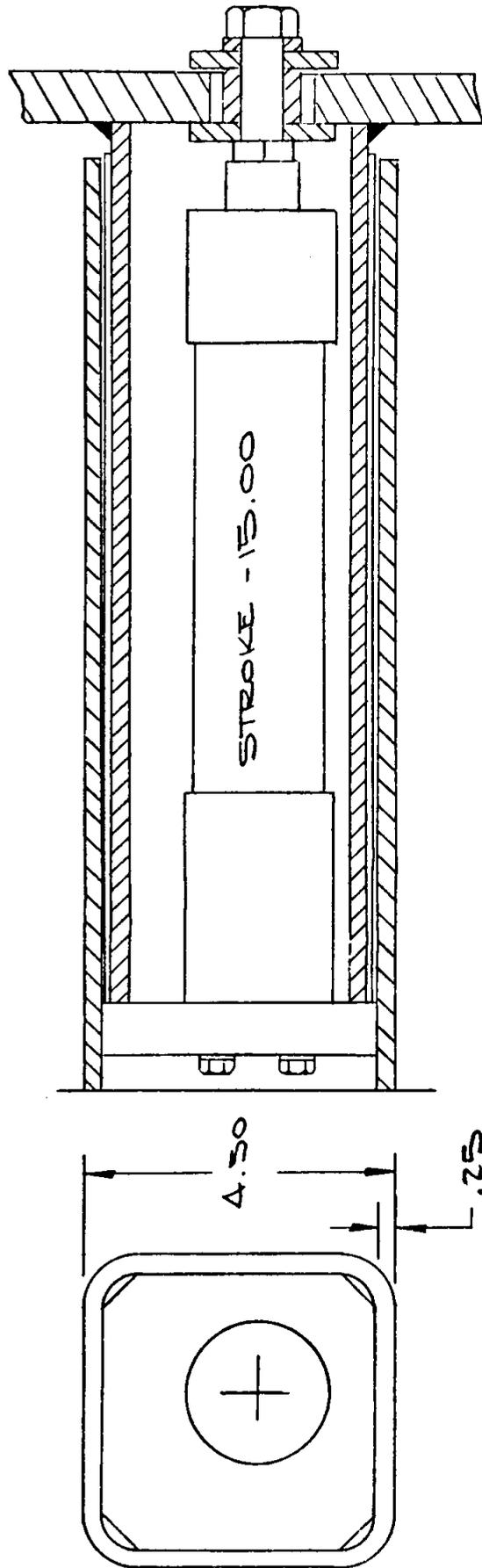


Figure 3-4. Canopy Support Post Assembly

Wooden mockups of three canopy tops were completed. These were a single flat plate, a wedge type with vertical sides, and a "pagoda" type with all four sides angled to a flat-top plane.

These mockups were reviewed with the USBM on March 11, 1974. They were installed on the shuttle car operator's pit mockup and examined with respect to operator visibility, and approach to accommodate roofing. It was decided that the mockups were ready for operator evaluation in the mine and that the dished, or saucer shaped, top was the preferred approach. Also examined was the protective deck at the middle of the pit. This was discussed with respect to installed height, effect on operator vision, and pit ingress and egress. With respect to the deck, the approach taken was to place the deck as low as possible consistent with requirements for getting in and out of the pit and clearance for the operator's knees. It appeared that the deck could be lowered such that it was flush with the machine frame and that hinging the deck would be necessary for getting in and out of the pit. Spring loading or counterweighting would be necessary for ease of lifting the deck. In connection with reviewing the deck arrangements with the USBM, it was concluded that the openings over the hand wheel control would have to be covered. It was planned to use a fixed guard suspended off the machine frame and extending outward such that the hand wheel would be covered.

3.3 In-Mine Testing of Mockups - On March 18-19, 1974, the Jewell Ridge Coal Company's No. 12 mine was visited and the shuttle car canopy wooden mockups were installed on the 21SC (standard) shuttle car in section 6-R. This is the same car that had the original canopy installation under USBM contract no. H0220031. The test was arranged such that the mockups were placed on the car at the conclusion of the first shift and the first-shift operator (6 ft 3 in. tall) was asked to sit in the pit and comment on various aspects of the canopy. The car remained stationary. All three canopies were tried and the canopies were placed at various heights. The same review was conducted with the second-shift operator (5 ft 7 in. tall). The following summarizes the comments.

a. Overall Height - The canopies are adjustable from 32 to 47 inches (a revision from the original contract no. H0220031 of 32 to 40 inches). The operators expressed the opinion that in the low positions (32 to 38 inches) vision might not be acceptable. In the high positions (38 to 47 inches), they believed that the canopies were reasonably acceptable. No. 12 mine height is around 52 inches and the canopies can be used at the higher end of the adjustment range.

b. Vision - Vision was much better than the original canopy, and probably acceptable in the higher overall height range. The first-shift operator was familiar with the original canopy; the second-shift operator knew of it, but hadn't operated the car with it installed. Both operators agreed with the general direction of the canopy concept with respect to seeking vision improvement.

c. Top Shape - The shaped or contoured top was preferred to the flat plate in order to give some wedge or lead effect in case the canopy is "roofed." The "pagoda" mockup had a 3 1/2-inch crown. It was anticipated that this "umbrella" shape might interfere with the cap lamp light path; however, this was not observed to be a problem during the in-mine evaluation. The preferred top shape is one that is crowned. The depth does not have to be 3 1/2 inches; it could be on the order of 1 1/2 to 2 inches.

d. Mine Roof Sensor - A spring loaded mechanical indicator, devised to engage the mine roof and give the operator a visual indication of canopy location with respect to the mine roof, was examined by the operators. Their opinion was that nothing of this sort was required in order to guard against the possibility of mis-setting the canopy too high in the course of the frequent height changes visualized for the independently controlled double ended canopy system. No further effort was made to devise a device of this kind.

e. Canopy Height Control - The independent control of both canopies from each end of the pit was considered to be desirable. Control location on the inboard side of the pit was considered to be satisfactory.

f. Protective Deck - Two heights of protective decks were evaluated (a low deck slightly lower than machine frame height and pivoted, and a fixed deck slightly higher than frame height). The large operator liked the higher fixed deck and the smaller operator liked the lower deck. The second-shift operator also expressed a liking for the hinged deck inasmuch as it would facilitate escape if the shuttle car stalled next to the rib. It was concluded that the best approach to take was to use the higher fixed deck. This avoids complications of pivoting and counterbalancing. The mine is high enough that the ultralow position is not required at this time.

g. Seat (From Standardization of Controls Contract) - The seat mockup from the Standardization of Controls contract was shown to the operators. It was not possible to locate the seat in the shuttle car because of interference with the welded-in existing seat. However, both operators sat in the seat outside the car and appeared to be favorably impressed with the potential improvement shown by the mock-up. The contour in the small of the back area was noted to be high as was previously noted by USBM and Bendix personnel.

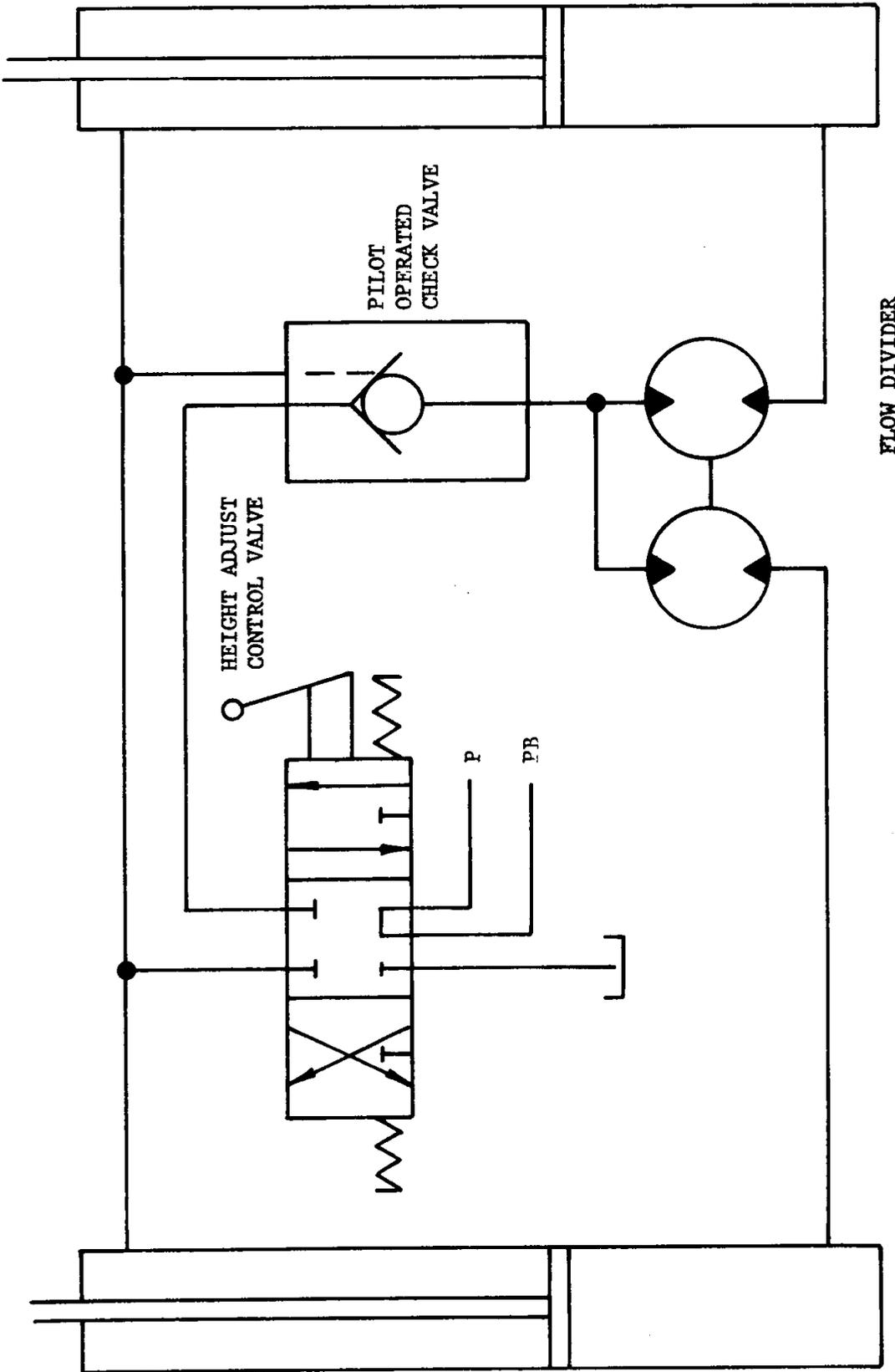
h. General Operator Comments - Both operators expressed the opinion that canopies constructed in accordance with the mockups and installed on the shuttle car would prove to be sufficiently acceptable to assure that a good amount of running time would be accumulated. (The operators refused to use the original canopies after just a few hours of operating time.)

3.4 Canopy Configuration - The top shape selected was a modified "pagoda" with a crown height of 2 1/2 inches. The top is made of nine flat plate panels welded together. This was selected over the "saucer" type on the basis that it lends itself better to fabrication by the coal operators.

3.4.1 Hydraulic Adjust Circuit - The canopy hydraulic height adjust circuit is shown in figure 3-5. The canopy at each end of the operator's compartment has its own separately controlled hydraulic circuit. The two cylinders supporting each canopy are connected in parallel and synchronized by use of a flow divider. Pilot operated check valves prevent down travel of the cylinders when the canopy is subjected to a vertical load such as a roof fall. The control valves for each canopy are located behind the operator's seat, and the handles extend, on the inboard side of the compartment, to points which are within convenient arm reach. (The hydraulic circuit for adjusting the modified canopies on the shuttle car was satisfactorily tested using the hydraulic system breadboard generated in the original canopy program.)

3.4.2 Canopy Load Test - A test fixture and instrumentation for load testing the shuttle car canopies was constructed using a hydraulic jack to apply a single point load. The load was read through a calibrated pressure gauge in the jack hydraulic circuit. See figure 3-6.

The shuttle car canopy load tests were completed and the canopies met all USBM requirements.



DOUBLE ACTING, SINGLE ENDED HYDRAULIC ACTUATORS

Figure 3-5. Hydraulic Circuit for Shuttle Car Canopy Height Adjust

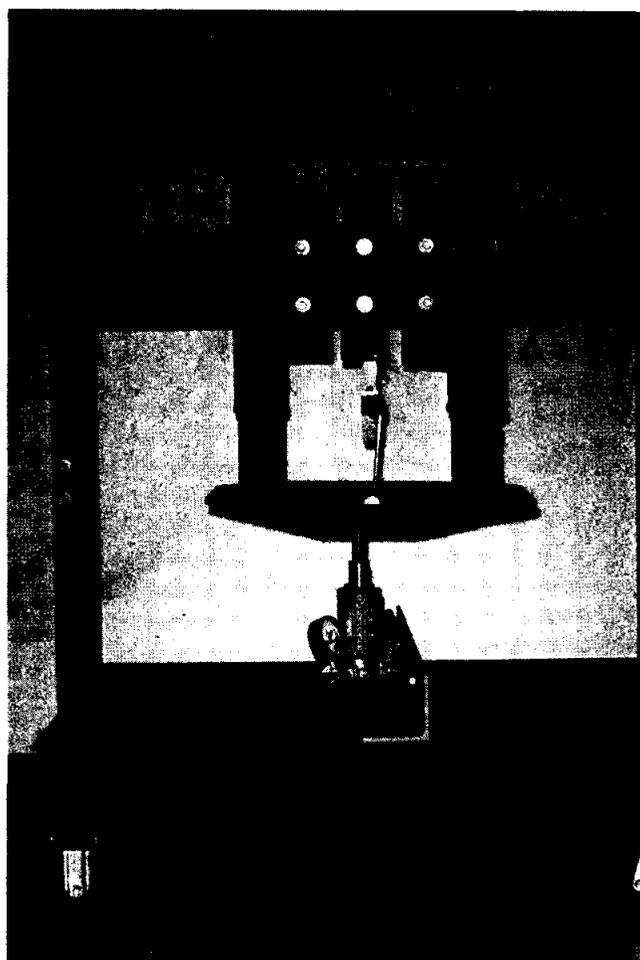


Figure 3-6. Canopy Test Fixture

3.5 Standardized Operator's Seat - The ASA standardized operator's seat fiberglass mockups, furnished by the USBM for in-mine evaluation on the shuttle car in this program, were closely examined. The seat was modified to give 25 degrees backward tilt capability from the normal upright position. This will not permit full recline position for the operator; however, further tilt pitches the seat bottom excessively. The canopy overall heights corresponding to upright and reclining seat positions are 47 inches and 43 inches, respectively. Thus, seat evaluation will occur at the higher canopy positions. When evaluating the canopies at lower heights, the ASA seat would have to be removed and the lay-down steel plate seats reinstalled.

Work continued on modifying and adapting the ASA standardized operator seat to the 21SC shuttle car being used in the canopy contract. Seat contour refinements, structural reinforcements, and installation-required changes were completed on one of the fiberglass mockups furnished by the USBM. This was accomplished by cutting off areas of the seat that caused interferences, and reinforcing and building up by overlaying with additional putty, fiberglass, and resin. This hand-tailored seat was then used as a pattern, and a mold was acquired for the additional seats required in the program. All design drawings were completed for the mounting brackets. A local upholstering concern specializing in recreational vehicle seat work was contacted, and arrangements were made with regard to making and installing the desired padding for the seat.

Work proceeded on the operator shockmounted seat feasibility study. A manufacturer's survey was made of shockmounted seats and suspension systems. An off-the-shelf suspension system was identified which was sufficiently adaptable to the ASA seat and 21SC shuttle car to enable an in-mine evaluation within the time frame of this program. Specified plans, with regard to the shock-mounted seat study include:

- a. Development of an idealized conceptual layout of a shock-mounted seat installation that would be compatible with the ASA seat, and the 21SC shuttle car.
- b. Procurement of an off-the-shelf seat suspension system and adapting it to the ASA seat and 21SC shuttle car in order to obtain an in-mine evaluation. This would not be an optimum installation inasmuch as it would be higher than desirable and not adjustable to a semiprone position. However, it would enable evaluation of the shockmount idea for the shuttle car.

Work continued on modifying and adapting the ASA standardized operator seat to the 21SC shuttle car being used in the canopy contract. Seat contour refinements, structural reinforcements, and installation-required changes were completed on one of the fiberglass mockups furnished by the USBM. A mold was made from this handtailored seat, and new seats were made.

The modified standardized seats were received and activity mating them to the mounting hardware was completed. They were then shipped to the mine for installation and evaluation the week of August 4. Two contoured seats were installed in the off-standard shuttle car without any difficulty, but seat adjustment was difficult because of an extensively bent side board.

3.6 Installation and In-Mine Evaluation - The shuttle car modification kit was transported to the mine during the week of August 4. The shuttle car canopy posts and the hydraulic parts were installed on the machine but the canopy hydraulic system was not connected to the machine hydraulic system at that time.

During the return visit to the mine on August 27-30 it was discovered that the outboard, left-hand canopy support tube had been bent toward the rear of the car. See figure 3-7. This was straightened by attaching a cable to the top bolt and pulling on it with a roof bolter.

The hydraulic hoses were then rerouted so that the valves could be turned around at each end with the control handles inboard instead of outboard. The valves then were connected in series with the boom lift valve, and the tank return line was connected to the clutch valve behind the control valve.

During installation of the center section of the canopy it was necessary to enlarge the bolt holes to get them lined up. Roof jacks were used across the car load area to push the side in line. The canopy installation was completed on August 29 at 8:00 a.m.

Upon entrance to the mine the next day it was found that the rear canopy section had been roofed and the tube structure had been bent back at an angle of about 15°. See figure 3-8. The inboard tube was jammed due to a "ding" impressed into it by contact with the steel pad left on the fender from the first installation of the original canopy. Both ends of the canopy tubes were extended above the structure by 11 1/4 inches at this time. All sections of the canopy were then removed. The jammed tube was pushed down with a roof jack against the roof.

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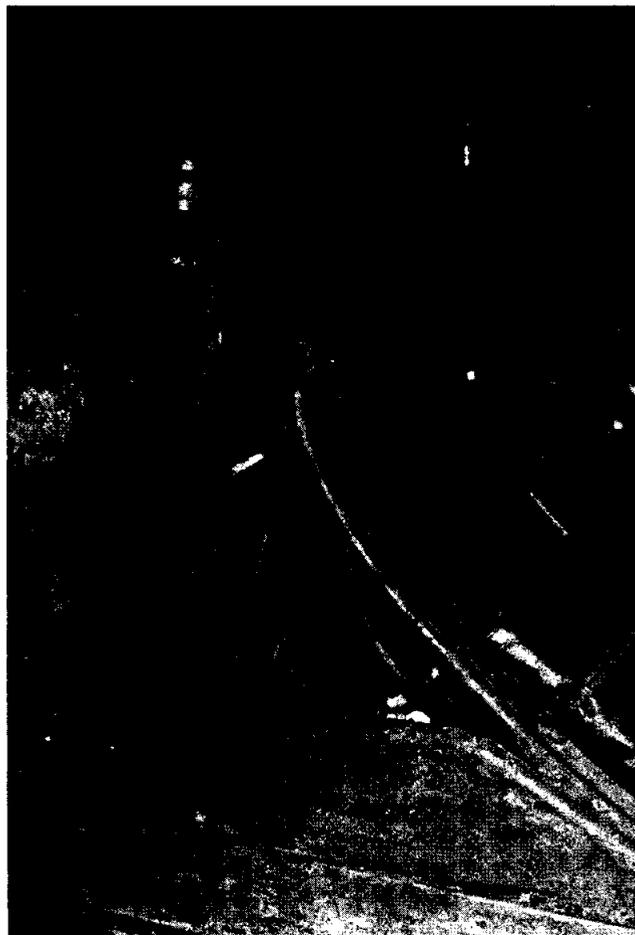


Figure 3-7. Bent Canopy Support Tube



Figure 3-8. Bent Canopy Support Structure

The contoured ASA standardized operator's seats were also removed from the other shuttle car due to the fact that after they were reclined fully they interfered with the operator foot pedal reach.

After arriving at the mine for the following visit on September 17-20 an examination of the shuttle car canopy structure installation showed that the left-hand structure had again been bent toward the rear of the car. This was again straightened by pulling on the top of the structure with a shuttle car attached with a cable.

An attempt was made to straighten the right-hand end. The fender was bent back at an angle, in addition to the "ding" in the tube, so the complete unit was removed from the shuttle car and delivered to the mine machine shop for removal of the "ding" and straightening of the structure plate. This was accomplished satisfactorily and returned to the mine the next day. No attempt was made to straighten the fender at this time.

The center deck was removed along with the forward tube structure. The center deck was objectionable to the operator because it was too close to his face and he had no protection to keep chunks of coal from sliding onto it and from there into him. See figure 3-9. To remedy this situation a drawing was made for the mine shop to modify the center section. It was made 12 inches narrower, with a round bar on the edge facing the operator, and four 3-inch vertical bars were installed along the edge to prevent chunks of coal, etc., from sliding onto the operator. See figure 3-10. This change was made by the mine shop crew.

On September 30 thru October 2 the right-hand fender was straightened by pulling on it with a cable attached to a battery operated tractor. The tube structures were reinstalled at both ends of the shuttle car with all six attach bolts. The hydraulic system was checked and all canopy sections were installed as shown in figure 3-11. The shuttle car canopy operation was then demonstrated to the USBM on October 2.

3.7 Installation and Maintenance Manual - The installation and maintenance manual for the shuttle car protective canopy has been changed to describe the modification involved.

3.8 Modification Drawings - Shuttle car canopy drawings that cover the canopy modifications are listed below:

X1933986 Rev A	Canopy Design Concept
X1933987 Rev A	Cylinder, Hydraulic
X1933983 Rev A	Canopy Adjustable, Shuttle Car
X1933982 Rev A	Canopy Center
X1933977 Rev A	Post Assembly, Canopy
X1933989 Rev A	ASA Seat Contour Modification
X1933988 Rev A	Seat Tilt and Slide Brackets

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Figure 3-9. Original Center Deck

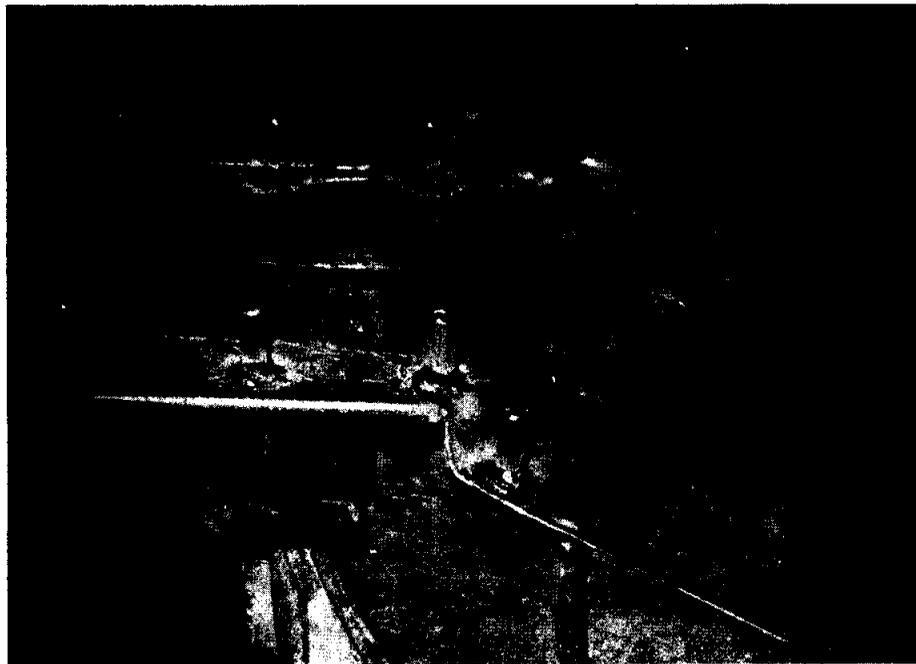


Figure 3-10. Revised Center Deck



Figure 3-11. Shuttle Car Canopy

4. LOADER CANOPY MODIFICATION

4.1 Background - The loader canopy developed under contract no. H0220031 had sustained damage to the hydraulic height adjust system during in-mine usage. Because of this and evidence pointing to a lack of need for hydraulic adjust, particularly in the demonstration mine, it was decided to revise the installation to a mechanical adjust configuration.

4.2 In-Mine Testing - The loader canopy was examined during the week of July 11, 1974, at the Jewell Ridge Coal Company's No. 12 mine to identify any damage that would interfere with installation of mechanically-adjustable, telescoping-pipe supports to support the canopy instead of the currently used hydraulically adjustable supports.

4.3 Installation and In-Mine Evaluations - Arrangements were made with the Jewell Ridge Coal Co.'s Mine No. 12 in White Wood, Va., for the installation of the loader canopy modification. All miscellaneous hardware necessary to complete the installation was obtained.

The modification of the loader canopy involved only the canopy support post structures wherein the hydraulic cylinders were removed and replaced with tube posts which telescope within the existing support posts. The mechanical stops within the existing posts limited the canopy minimum collapsed height. Minimum overall height after the modification is 38 inches and maximum overall height is 48 inches. This is compatible with the higher mining heights (approximately 52 inches) prevailing in the No. 12 mine. These posts had pins for various height positions. The old posts were removed and the new posts were installed during the week of August 4. See figures 4-1 and 4-2.

4.4 Installation and Maintenance Manual - The installation and maintenance manual has been changed to describe the modification involved.

4.5 Modification Drawings - Listed below are all drawings covering the loader canopy modification:

X1933802 Rev A	Canopy Design Concept
X1933975 Rev A	Canopy Cylinder Assembly, Mechanical

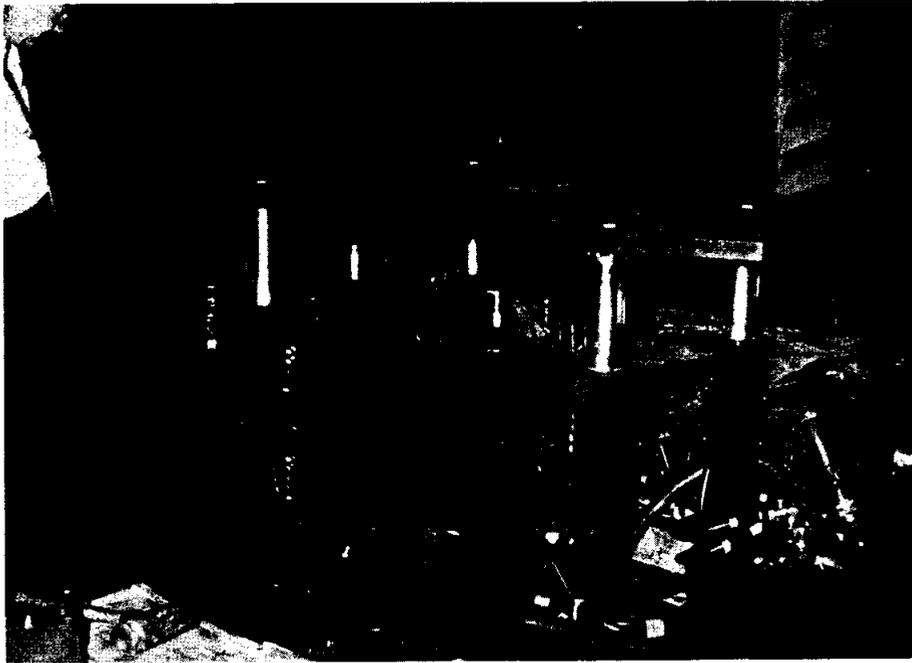


Figure 4-1. Original Hydraulic Canopy

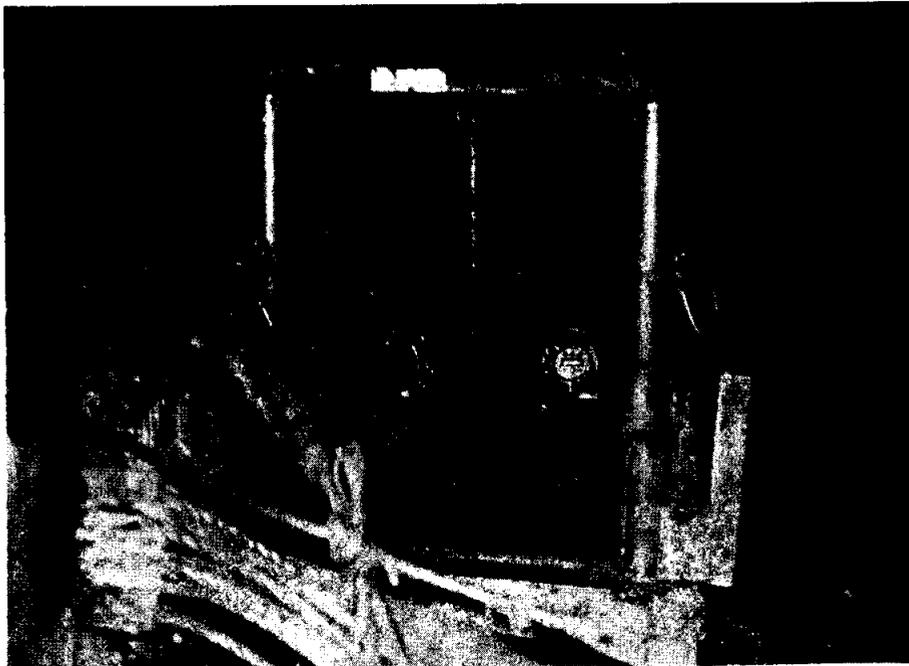


Figure 4-2. Mechanically Adjustable Canopy

5. ROOF DRILL CANOPY MODIFICATION

5.1 Background - The protective canopy designed and built under contract no. H0220031 was installed on a Galis 300 roof drill in the Jewell Ridge Big Creek Tiller mine. It was found that trammng of the machine was degraded to the extent that normal roof bolting could not be maintained. The flexible flooring installed in the front bumper was made from a heavy, stiff conveyor belting, 15/32 inches thick, and was installed in such a manner that it "bellied" down to the mine floor and dragged on the floor. Because of the extra weight of the canopy, and the stiffness of the floor material, loose coal on the floor of the mine piled up in front of the machine as it was trammed forward, causing a "bulldozing" effect. It had been expected that the floor would slide up over this loose material on the floor, but the bulldozing effect of the floor material, combined with the weight of the canopy, impaired the trammng capability of the machine.

5.2 In-Mine Testing - During the week of February 11, 1974, the roof drill canopy was removed from the roof drill in the Jewell Ridge Big Creek Tiller mine and installed on a roof drill in the No. 12 mine, except that the heavy flexible flooring material was not installed. Under these conditions, machine trammng did not appear to be degraded, and the bulldozing effect was entirely eliminated.

Figure 5-1 shows the roof drill trammng without the heavy flexible floor. Note that the front bar does not drag nor bulldoze the loose coal on the mine floor.

Another visit to the No. 12 mine was made on March 18-19, and the test was repeated. This test was witnessed by Mr. George Judy of George Judy Associates and Mr. James Ault of the USBM. Trammng was again accomplished without degradation of machine operation.

It was decided to install a lighter (1/4-inch thick) flexible material with a shallower belly as a floor and repeat the tram test. The material was attached to flat plates welded to the front structure at about 45° to the floor. See figure 5-2. The machine was trammed with the operator seated in the flexible floor and trammng was accomplished with no more difficulty than experienced without the floor installed.

Figure 5-3 shows how the shallower, lighter flexible floor contacts the mine floor mainly at the center of the floor area. The front frame of the canopy structure remains above the mine floor and does not bulldoze. It was decided that the bumper bar did not need to be raised higher.

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Figure 5-1. Tram Test Without Flexible Floor

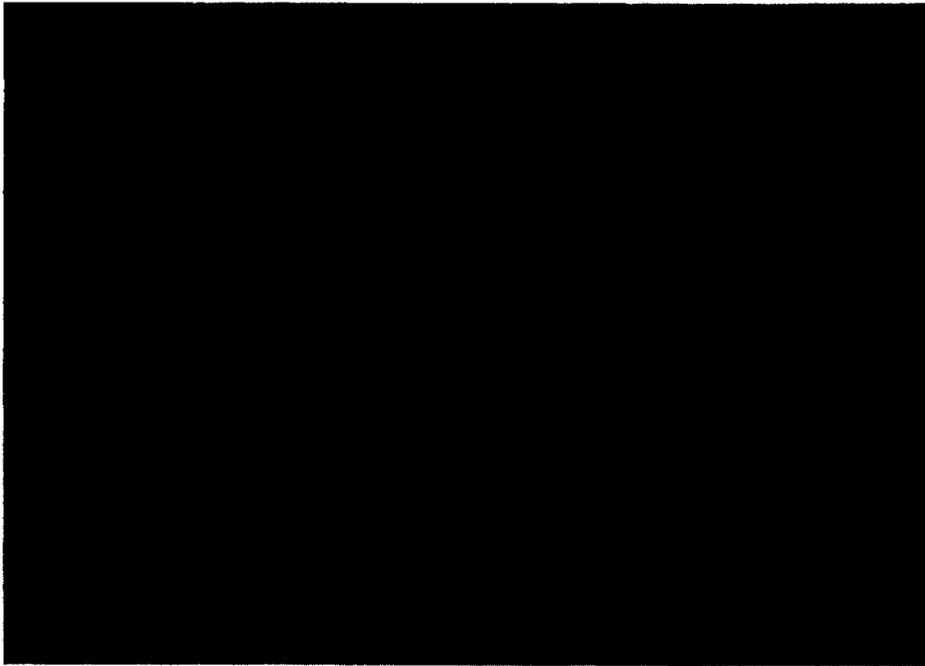


Figure 5-2. Forty-Five Degree Flexible Floor Attachment Plates



Figure 5-3. Flexible Floor Contact With Mine Floor

It was concluded from observation of the adequate machine tramming capability with the lighter flooring material installed at a shallow angle, that the bulldozing was caused by the heavy flexible floor material originally used in the Big Creek Tiller mine. The canopy frame structure with the lighter flexible floor installed remained on the bolter in the No. 12 mine and was used for bolting operations for several weeks of trial. It was reported to be successfully operated by mine personnel during that time. Figure 5-4 shows the roof drill in operation with the flexible floor in place.

Mine reports indicated that operation of the machine was sufficiently acceptable to justify going ahead with other planned modifications involving the height adjust assembly and the roof jack. The mechanical telescoping post assemblies were to be used to support the rear of the canopy, and the roof jack was to be extended with a spacer to give operational capability in higher mining heights. Canopy aft height would be adjustable between 38 and 48 inches, and the roof jack would be operable between 40 and 52 inches.

5.3 Modification Drawings - Modification drawings for the roof bolter canopy are listed below:

X1933800-1 Rev A	Canopy Design Concept
X1933823-1 Rev A	Frame, Support, Roof Jack
X1933990-1 Rev A	Canopy Stop
X1933984-1 Rev A	Bolt, Special
X1933985-1 Rev A	Sleeve Extension
X1933826-1 Rev A	Floor Pan, Flexible
X1933796-1 Rev A	Fitting, Canopy
X1933975-1 Rev A	Canopy Cylinder Assembly, Mechanical

5.4 Installation and In-Mine Evaluation - The manual-adjust posts were taken to the mine the week of August 4 but were not installed because the machine was not in the expected condition and miscellaneous parts from the original installation were missing. During a visit to Jewell Ridge Mine No. 12 on September 13, an inventory was made of miscellaneous bolter canopy installation parts. As a result of some missing parts it was necessary to revise the installation slightly.

It was decided on September 17 to revise the bolter canopy hydraulic system by leaving out the accumulator since its use would probably be negated by leakage back through the control valve anyway and the pilot operated check valve is intended to hold the roof jack preloaded to 2 tons (570 psi). A relief

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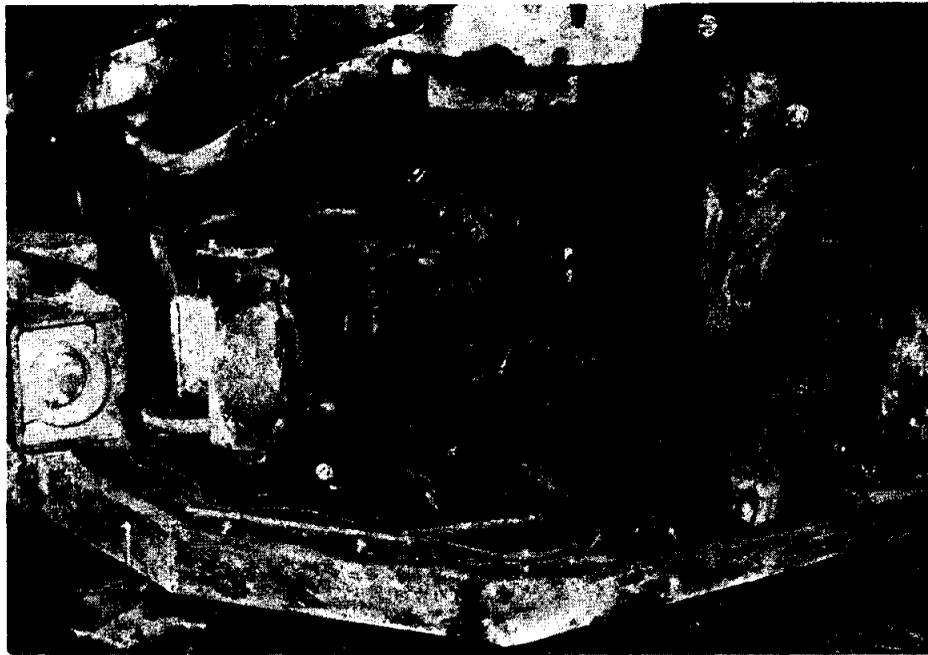


Figure 5-4. Preparing to Drill With Flexible
Floor in Place

valve from the unused cutter canopy was used as the 570 psi bypass valve on the bolter canopy. The pilot operated check valve and the 10-ton relief valve were mounted on 1/4-inch steel plate and installed in the tube structure support area by welding them in place. Also welded a mounting plate in place for the control valve.

It was determined that a new part was required to prevent the roof jack spring from sagging to the floor when tramming with the jack retracted and held only by spring preload. This is due to the roof jack extension added to provide higher reach for the roof jack, part no. X1933985-1.

The lengths of the 1/4-inch hose required for hydraulic hook-ups of the roof jack on the bolter were determined and these were ordered at the mine stock room.

The roof jack housing which was packed solid with coal dust was cleaned out. This entailed complete disassembly of the actuator from the housing and spring. The attempt to clear the frame for 1/4-inch hose entry failed.

The control valve for the bolter roof jack was then brought into the mine (with the relief valve previously set at Denver at 1,200 psi) and the relief valve was set at 600 psi for roof jack bypass pressure. Also 1/4-inch, 1/2-inch, and 3/4-inch hoses were brought in to hook up the bolter roof jack hydraulics.

Hydraulics on the roof jack were connected. The roof jack extension and the canopy spacer were installed. The mechanical adjust tubes were installed to support the rear of the canopy. The canopy top was then added. The demonstration to the USBM occurred on Wednesday, October 2 at 8:00 a.m. Configuration was as shown in figures 5-5 and 5-6.

5.5 Installation and Maintenance Manual - The installation and maintenance manual for the roof drill has been changed to describe the modification involved.

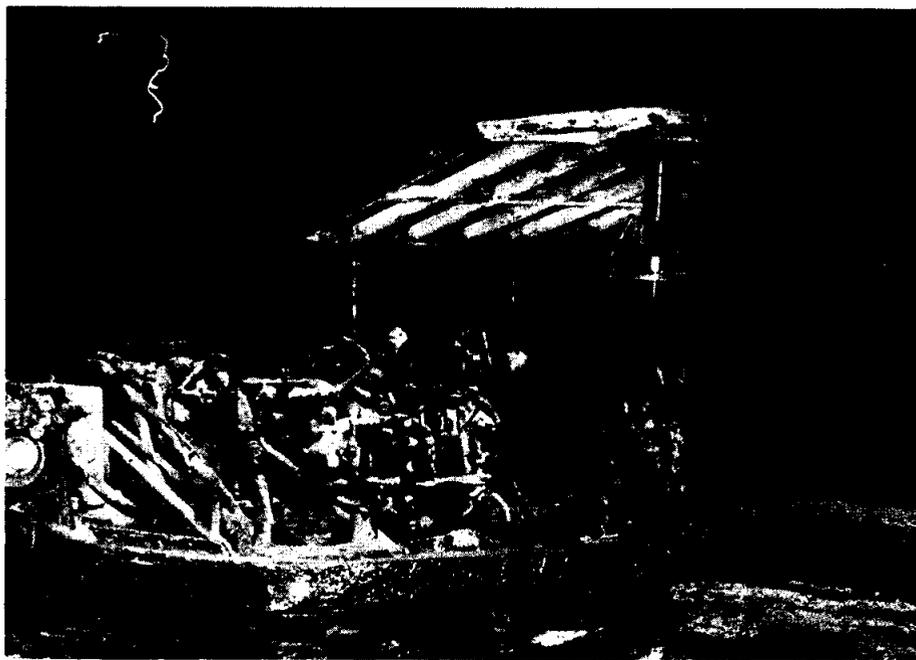


Figure 5-5. Roof Drill With Canopy



Figure 5-6. Roof Drill in Operation With Canopy

6. SUBJECT INVENTIONS

"There has been no invention, discovery, improvement, or development (whether or not patentable) made in the performance of the experimental, developmental, or research work under this contract or any subcontract thereunder."

7. CONCLUSIONS

7.1 Shuttle Car Canopy Modifications - The objective to provide greater operator visibility has been met by implementing the three-section, cantilevered canopy concept. The operator has much improved roof vision, and vision across the conveyor has also improved greatly. Operator acceptance has greatly increased over the original canopy.

As a result of operator evaluation of the ASA standardized seat in the off-standard shuttle car it can be concluded that this specific seat form is not adaptable to shuttle cars which operate in seam heights of less than 55 inches. When the seat is in the lowest position the bottom portion of the seat is raised too high for the operator to stretch his legs and reach the foot pedals.

7.2 Modification of the Loader Canopy - The replacement of the hydraulic jacking mechanism with a manual adjustment system completely satisfied the required added adjustment levels and was well received by the operators. Removal of all hydraulic canopy support equipment from the operator cab gave the operator some additional space, which will add somewhat to increased comfort.

7.3 Modification of the Roof Drill Canopy - The problem of the canopy floor tendency to "snow plow" has been eliminated and the overall canopy has been improved by a better hydraulic system and an added downstop spacer.

7.4 Face Drill and Cutter Canopy Installations - The basic canopies are structurally adequate and are acceptable to the operators. Hydraulic adjust is not required on these machines, particularly in mining heights existing in the demonstration mine (approximately 52 inches). Canopy installations at both left-hand and right-hand stations on the cutter are not necessary. The demonstration mine uses the left-hand station exclusively and has deactivated controls in the right-hand pit.

8. RECOMMENDATIONS

The conclusions which have been the result of this program indicate that several improvements are still required in order to perfect the canopies.

It was found that, for future shuttle canopy installation, it will be necessary for the operator compartment structure which supports the canopy to be substantially strengthened.

Since the ASA standardized seat can not be adapted to mine heights of less than 55 inches, the seat will have to be altered and possibly hinged at the seat reference point. The alternative would be to redesign a new seat which would lend itself particularly to lower coal seams.

The canopies on the loader and on the roof drill are being accepted and even praised by the operators and should be installed on more machines in order to get more exposure of these canopies to the miners and mine operators.

