

A minerals research contract report

Final Report

February 1983

U.S. DEPARTMENT OF LABOR MSHA



00031818

DEMONSTRATION OF FRESNEL LENS BLIND AREA VIEWERS ON LARGE UNDERGROUND MINE VEHICLES

U.S. Bureau of Mines
Twin Cities Research Center
LIBRARY

Contract No. J0215029
Tracor MBA

OFR
84-111

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR



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

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No.
4. Title and Subtitle Demonstration of Fresnel Lens Blind Area Viewers on Large Underground Mine Vehicles		5. Report Date December 1982	
7. Author(s) James L. Eirls		6.	
9. Performing Organization Name and Address Tracor MBA Bollinger Canyon Road San Ramon, California 94583		8. Performing Organization Rept. No.	
12. Sponsoring Organization Name and Address Office of the Assistant Director of Mining U. S. Bureau of Mines Department of the Interior Washington, D.C. 20241		10. Project/Task/Work Unit No.	
		11. Contract(C) or Grant(G) No. (C) J0215029 (G)	
		13. Type of Report & Period Covered Final Report Sept. 81 - Dec. 82	
15. Supplementary Notes		14.	
16. Abstract (Limit: 200 words) The low profile, fresnel lens, Blind Area Viewer (BAV) developed under the completed USBM Contract H0262022, "Improved Visibility Systems for Large Haulage Vehicles" for use on large haulage vehicles in open pit mines was tested for use in underground mines. This evaluation was made to determine the BAV's adaptability to the underground environment. The novel device's safety potential was verified at two test mines as operators found the BAV useful in observing well lighted objects in otherwise normally blind areas; although limited clearance for large vehicles in some areas caused damage problems. The limited vehicular traffic in the underground mines did not emphasize the inherent value or cost effectiveness of the BAV on underground haulage vehicles as it had on large vehicles in open pit mines.			
17. Document Analysis a. Descriptors Haulage Trucks, Load Haul Dump, Teletram, Front Wheel Loaders, Fresnel Lens, Work Face, Haulage Entries, Dump Stations. b. Identifiers/Open-Ended Terms View, visibility, blind area, field-of-view, haulage, productivity, safety, accident avoidance.			
c. COSATI Field/Group			
18. Availability Statement Release Unlimited		19. Security Class (This Report) Unclassified	21. No. of Pages 42
		20. Security Class (This Page) Unclassified	22. Price



FOREWORD

This report was prepared by Tracor MBA of California under USBM Contract J0215029. The contract was initiated under the Federal Coal Mines Health and Safety Program. It was administered under the technical direction of Twin Cities Mining Research Center with Mr. Guy A. Johnson as Technical Project Officer. Mr. R.J. Simonich was the contract administrator for the Bureau of Mines. This report is the summary of the work carried out over the period of September 1981 to December 1982.

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
	EXECUTIVE SUMMARY	1
1.0	INTRODUCTION	2
1.1	Background	2
1.2	Objective	2
1.3	Scope	3
1.4	Mine Selection	4
2.0	INSTALLATIONS	4
2.1	Mines Interviewed, Visited and Selected	4
2.1.1	" " " "	4
2.1.2	Mines Visited	5
2.1.3	Mines Selected	5
2.2	Vehicles Used and Mountings Required	5
2.2.1	International Salt Company	5
2.2.2	Ozark Lead Company	16
2.3	Lighting	21
2.3.1	International Salt Company	21
2.3.2	Ozark Lead Company	22
2.4	Environmental Conditions	22
2.4.1	International Salt Company	22
2.4.2	Ozark Lead Company	22
3.0	TEST RESULTS	23
3.1	International Salt Company	23
3.1.1	BAV Survival Rate	23
3.1.2	Operator's Comments	25
3.1.3	Safety Department's Comments	25
3.1.4	Maintenance Department's Comments	25
3.1.5	Management's Comments	26
3.1.6	Overall Evaluation	26
3.2	Ozark Lead Company	27
3.2.1	BAV Survival Rate	27
3.2.3	Safety Department's Comments	30
3.2.4	Maintenance Department's Comments	30
3.2.5	Management's Comments	30
3.2.6	Overall Evaluation	30
4.0	CONCLUSIONS	31
5.0	RECOMMENDATIONS	31
	APPENDIX	32-38

LIST OF ILLUSTRATIONS

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
2.2.1-1	Driver's View Directly to Right Side	6
2.2.1-2	Driver's View Towards Right Rear	6
2.2.1-3	Right Rear Wheel Area Wagner Teletram Vehicle	8
2.2.1-4	Right Front Wheel Area Wagner Teletram	9
2.2.1-5	Right Front Wheel Area Wagner Teletram	9
2.2.1-6	Right Side of Wagner Teletram With BAV in Experimental Position	10
2.2.1-7	Blind Areas Plotted For Wagner Teletram Showing Possible Visibility Improvements With BAV	11
2.2.1-8	EIMCO 920 LHD	12
2.2.1-9	Plotted Blind Areas For EIMCO 920 LHD and Improvements in Visibility Possible with BAV	13
2.2.1-10	BAV Installation On EIMCO LHD	14
2.2.1-11	BAV Installation On EIMCO LHD	14
2.2.1-12	Driver's Position Relative to BAV	15
2.2.1-13	Driver's View of BAV	15
2.2.2-1	BAV Mounted On Wagner 21 Ton Truck	17
2.2.2-2	BAV Mounted On Wagner 35 Ton Truck	17
2.2.2-3	Top View of BAV & Mounting Bracket On Wagner 35 Ton Truck	18
2.2.2-4	Decal For Vehicles With BAV	18
2.2.2-5	BAV Decal For Truck Cab	19
2.2.2-6	BAV Decal For Front End Loader Cab	19
2.2.2-7	BAV Installation On CAT 980C Front End Loader	20
2.2.2-8	Driver's View Of BAV On CAT 980C F.E.L.	20
2.2.2-9	BAV Decal On F.E.L.	20
3.1.1-1	Damaged BAV On EIMCO LHD	24
3.2.1-1	Damaged BAV Removed From Caterpillar Front End Loader	28
3.2.1-2	Damaged BAV on Wagner Truck	29

EXECUTIVE SUMMARY

The fresnel lens Blind Area Viewer (BAV) developed, December 1978, under USBM Contract H0262022 "Improved Visibility Systems for Large Haulage Vehicles" proved so successful in large open pit mines that its applicability to large underground mines was evaluated. This was accomplished by testing the BAV on EIMCO 10 cubic yard Load-Haul Dump vehicles in a salt mine and on a Wagner 30 ton rear dump truck in a lead mine. Test results proved the BAV could be used in underground mines without major alteration, but for adequate life should be used where there were minimum overhead restrictions. Simple flood lighting was adequate in the salt mine where the light colored ore had excellent reflection characteristics. Using even more intense illumination in the lead mine (where there was very little contrast between men, vehicles and mine surroundings) it was difficult to obtain a clear decisive image in the BAV lens. Thus, the viewer could not be used to determine distance between machine and rib or pillar (both of same color).

With the well defined roadways usually found underground, limited and restrictive vehicular traffic, there are very few occasions where a hazardous object might be encountered in a vehicle's blind area, thus minimizing the advantage of a BAV. As a result, it was concluded that Blind Area Viewers could be used in underground mining operations, but should be recommended to only the larger, more spacious mines employing the very large mining equipment and good lighting conditions.

1.0 INTRODUCTION

1.1 Background

The fresnel lens blind area viewer (BAV) developed under USBM Contract H0262022, "Improved Visibility Systems for Large Haulage Vehicles" for use on large haulage vehicles in open mines was so well received by the test mines that it was introduced to the mining industry commercially by Tracor MBA. During the introduction (through exhibits at the International Coal Mining Show and other mining equipment shows) comments received indicated that the final R & D step for this novel hardware was to determine if it might readily be used on some of the large equipment in underground mines.

The purpose of this investigation was to determine the effectiveness of the blind area viewers when used in underground mining environments. The problems anticipated were the limited artificial lighting ventilation, humidity and restricted space for operation.

The blind area viewer development work was covered in final report entitled "Improved Visibility Systems for Large Haulage Vehicles" dated January 1982. Copies can be obtained from Mr. Guy A. Johnson, USBM Twin Cities Research Center, 5629 Minnehaha Ave. So., Minneapolis, MN 55417.

1.2 Objective

The objective was to test the effectiveness and usefulness of the BAVs on underground mining equipment through their demonstrated performance, durability and acceptability by the operators from actual in-mine tests over reasonable lengths of time.

1.3 Scope

To obtain sufficient information for reliable evaluation of the blind area viewers the BAVs were in-mine, on-vehicle tested in different underground mining environments and on several different types of vehicles.

The mines selected were a salt mine and a lead mine. The equipment selected were front end loaders, haulage trucks and a fork lift.

The testing took place over a period of three to four months in each of the test mines. The BAVs were first tested in the salt mine, then moved to the lead mine in order to provide as long a test period as possible for each BAV since a BAV has a relatively long life under normal conditions.

The demonstration tests were monitored by personal visits of the Tracor MBA engineer who inspected the BAVs and questioned equipment operators, maintenance personnel, safety department personnel and mine managers. Inbetween mine inspection visits, telephone contact was maintained with key personnel at the mine for timely information on the performance of the blind area viewers.

At the end of the in-mine evaluations the units were removed from the test vehicles and inspected for defects or deterioration. All were returned to USBM Twin Cities Research Center, Minneapolis, MN for use in their continuing collision protection program.

1.4 Mine Selection

A large number of mines were interviewed by telephone in order to select the optimum test sites. The majority were not using equipment large enough to warrant the use of a BAV, or did not feel they had any problems associated with lack of operator visibility. The oil shale mines in Colorado, which were most desirable and logical because of the planned large underground workings and their use of very large equipment, were just completing the initial pilot test mines and were not scheduled to start production on a full scale basis in the immediate future. Thus, they were not considered for demonstration mines.

The mines selected were a large salt mine in Ohio and a lead mine in Missouri.

2.0 INSTALLATIONS

2.1 Mines Interviewed, Visited and Selected

2.1.1 The oil shale mines interviewed were: Tosco Corporation's Mine, the Lone Ridge Mine (Union Oil Co.), the Coloney Project (EXXON) and the Occidental Oil Shale Inc. Mining Operations in Grand Junction, Colorado.

Other mining companies contacted were:

Morton Salt Co., Painsville, Ohio
International Salt Co.'s mine in Ratsof, NY.
International Salt Co.'s mine in Cleveland, Ohio
Dravo Lime Co. in Marysville, KY
White Pine Copper Co.'s mine in White Pine, Michigan
Ozark Lead Co.'s mine in Sweetwater, MO
AMAX Lead Co.'s Buick mine in Boss, MO
Texas Gulf and Chemical Co. mine in WYO
Southern Utah Fuel in Salina, Utah, and
Consolidation Coal Co., in PA.

2.1.2 Mines Visited

Those mines that expressed interest in the program and a willingness to participate were visited. These were: International Salt Co. of Ratsof, NY, the International Salt Co.'s mine in Cleveland, Ohio, St. Joe Lead, in Viburnum, MO and the Ozark Lead mine in Sweetwater, MO.

2.1.3 Mines Selected

The two mines selected were the Cleveland Ohio mine of International Salt Co. and the Ozark Lead mine in Sweetwater, MO.

2.2 Vehicles Used and Mountings Required

2.2.1 International Salt Company

It was planned to put Blind Area Viewers on an EIMCO 920 LHD with 14 cubic yard bucket capacity and a Wagner MTT 426 which has a 26 ton rated capacity (a Teletram truck). Copies of specification sheets for these vehicles are included in the Appendix.

It was found that the Wagner Teletram, in use at the Cleveland mine of International Salt Company, was especially designed for this particular mine. Its superstructure did not conform with the Wagner vehicles inspected at the Wagner manufacturing facilities or with the specification sheets. The driver's view to the right side vehicle was blocked except for a small area approximately 2 ft. square directly to the right of his vehicle. The rearward view (on the right side) was also obstructed by several items that would make it very difficult to utilize a blind area viewer without blocking the driver's only view in that direction also. Photographs showing the driver's view directly to the right side and the right rearward directions are shown in Figures 2.2.1-1 and -2 respectively.

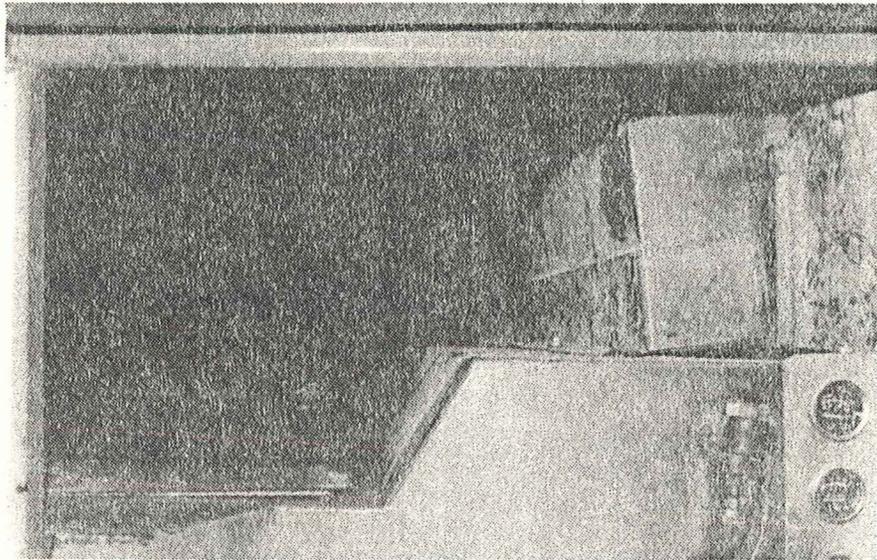


FIGURE 2.2.1-1
DRIVER'S VIEW DIRECTLY TO RIGHT SIDE

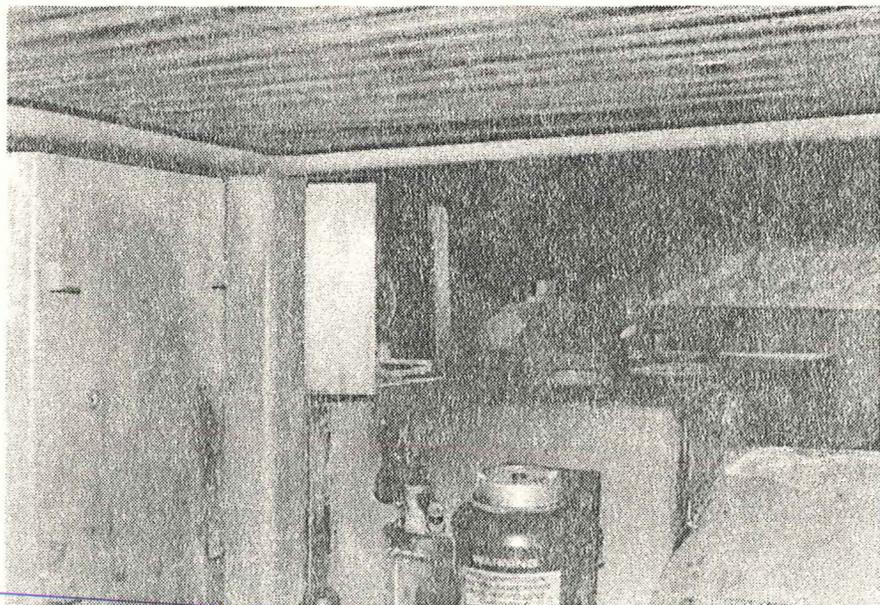


FIGURE 2.2.1-2
DRIVER'S VIEW TOWARDS RIGHT REAR

The driver's blind area, with which he was most concerned was that in the vicinity of the right rear wheel. This area is shown in Figure 2.2.1-3. To utilize the blind area viewer to see objects in this particular area would require that the BAV be mounted in back of the right front wheel, however, this was not practical with this vehicle's configuration. See Figures 2.2.1-4 and -5. The other possibility was to mount the blind area viewer directly opposite the driver positioning the blind area viewer on its side so the 70° angle of viewing was pointed towards the rear right side. Figure 2.2.1-6 shows the blind area viewer temporarily in this experimental position. However, this position was not deemed feasible for an installation of the BAV as it would block the driver's view which he was accustomed to using in positioning the vehicle under the loading hopper. Thus the Wagner teletram being used at the International Salt Company's mine in Cleveland Ohio was not used for the testing of the BAV. Figure 2.2.1-7 shows previously calculated visibility improvements with BAV.

BAVs were then installed on the right rear corner of two EIMCO 920 LHDs. The bucket end of the LHD was considered as the front of the vehicle.

The EIMCO 920 LHD is not a very large vehicle as shown in Figure 2.2.1-8. However, a small vehicle approximately 3 feet high could be blocked from the operator's view up to as much as 16 feet away from the vehicle, Figure 2.2.1-9. Vehicles this size (converted golf carts) are used in this mine for personnel transportation.

In order not to interfere with normal maintenance procedures, it was necessary to build a three-leg bracket on which to mount the BAV. See Figures 2.2.1-10 and -11. This bracket was designed so that it could be installed or removed readily. It was attached to the vehicle by three bolts with the nuts welded to the vehicle frame. The BAV was mounted on top of the bracket using its normal mounting hardware and rubber vibration dampers.

Figure 2.2.1-12 is an overall view showing the driver's position relative to the BAV. Figure 2.2.1-13 is a photograph showing the driver's view of the BAV. These photographs were taken in the underground shop maintenance area.



FIGURE 2.2.1-3
RIGHT REAR WHEEL AREA WAGNER TELETRAM VEHICLE

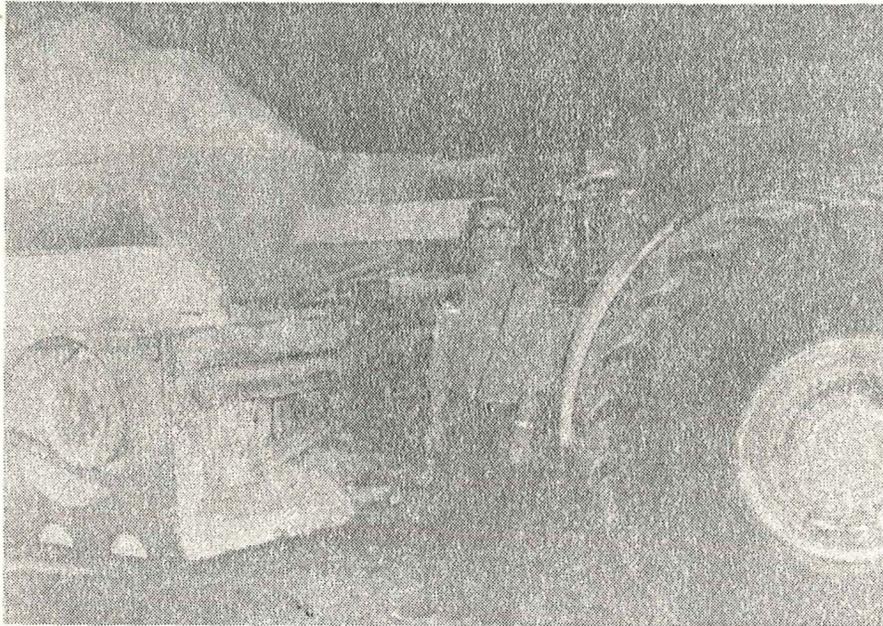


FIGURE 2.2.1-4
RIGHT FRONT WHEEL AREA WAGNER TELETRAM

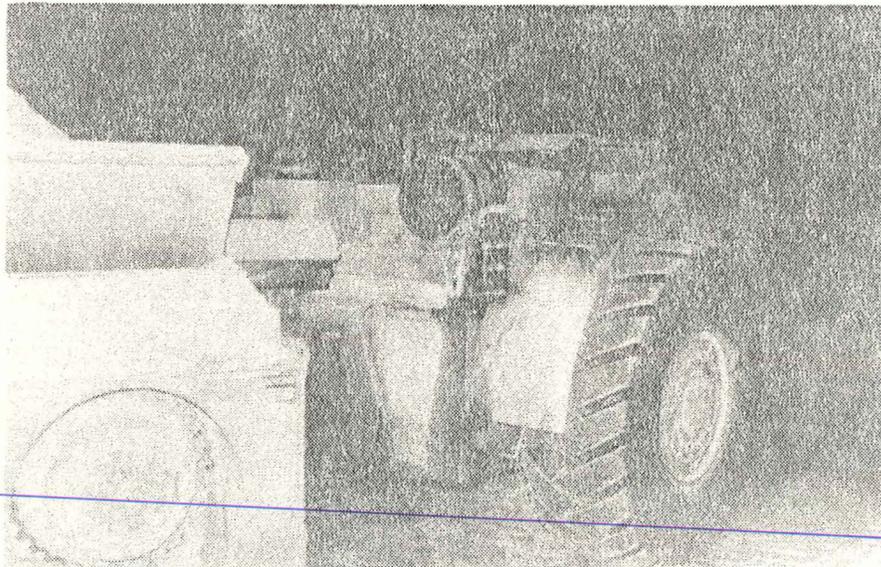
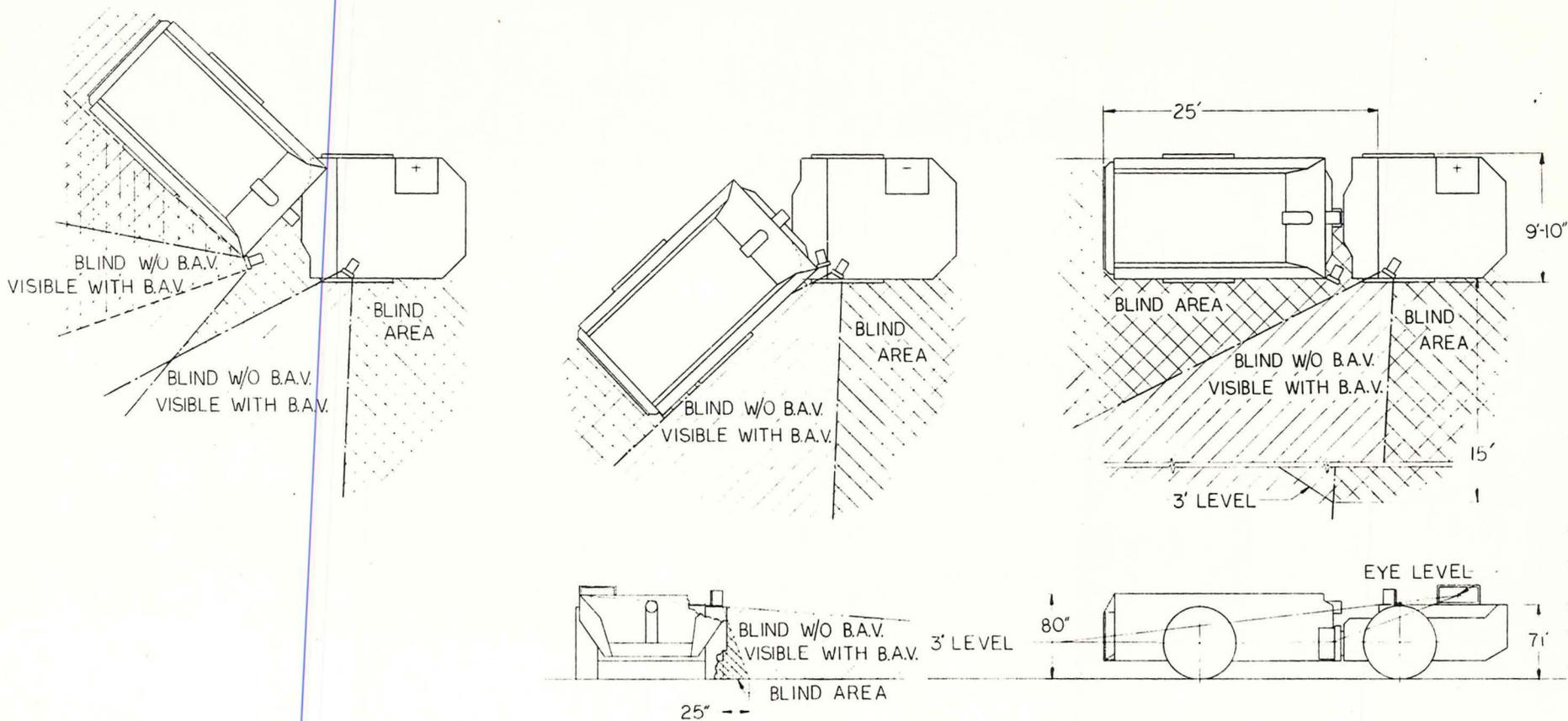


FIGURE 2.2.1-5
RIGHT FRONT WHEEL AREA WAGNER TELETRAM



FIGURE 2.2.1-6
RIGHT SIDE OF WAGNER TELETRAM WITH BAV IN
EXPERIMENTAL POSITION

Tracor MBA



WAGNER MODEL
MTT-426-23

FIGURE 2.2.1-7
BLIND AREAS PLOTTED FOR WAGNER TELETRAM
SHOWING POSSIBLE VISIBILITY IMPROVEMENTS WITH BAV

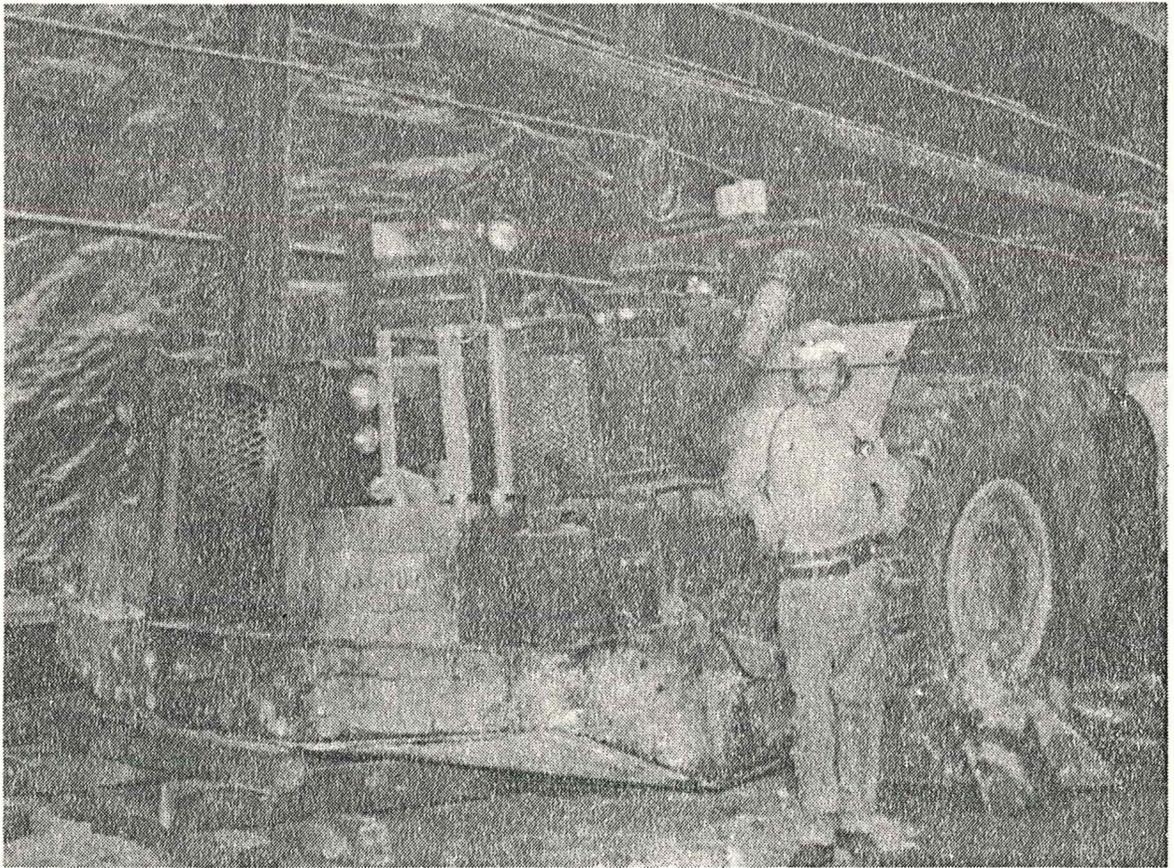
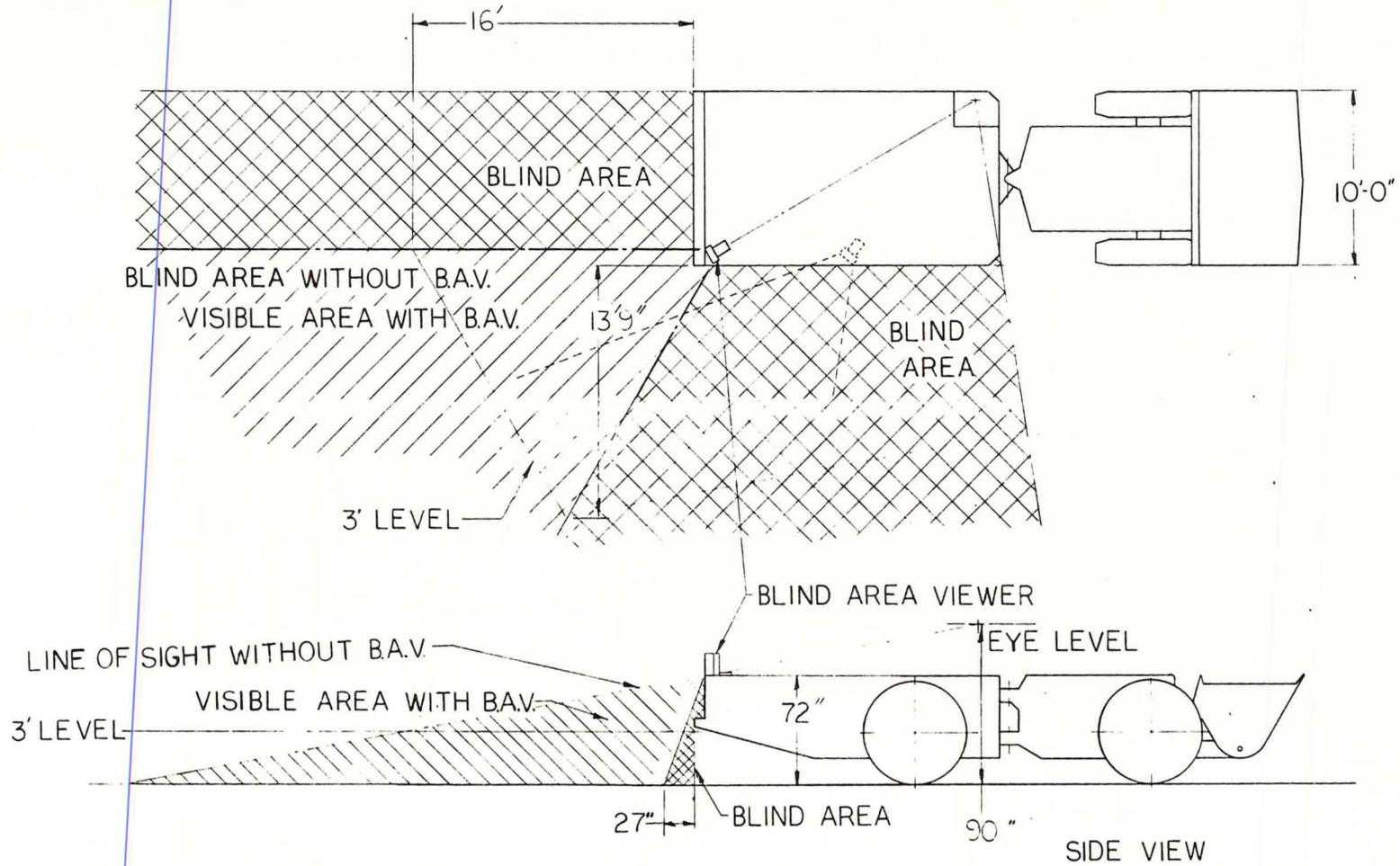


FIGURE 2.2.1-8
EIMCO 920 LHD

Tracor MBA



EIMCO MODEL
920C LHD

FIGURE 2.2.1-9
PLOTTED BLIND AREAS FOR EIMCO 920 LHD AND IMPROVEMENTS
IN VISIBILITY POSSIBLE WITH BAV

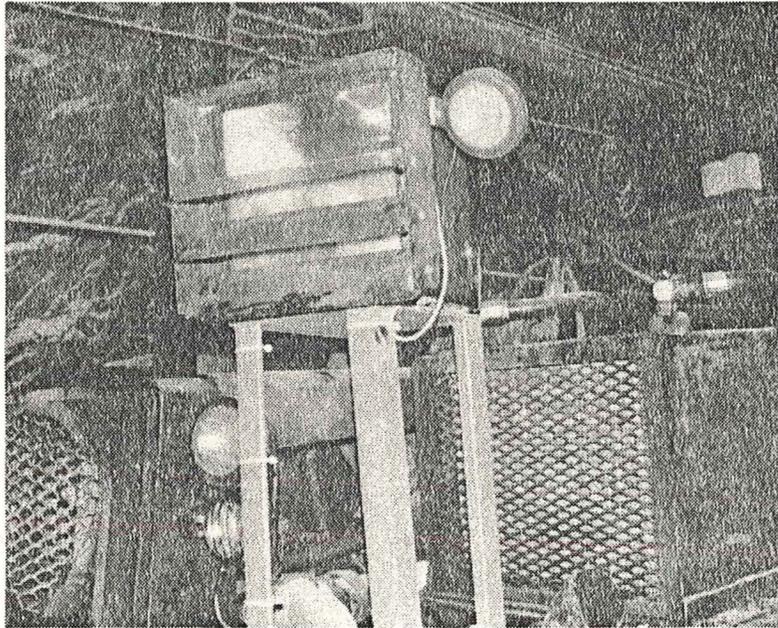


FIGURE 2.2.1-10
BAV INSTALLATION ON EIMCO LHD

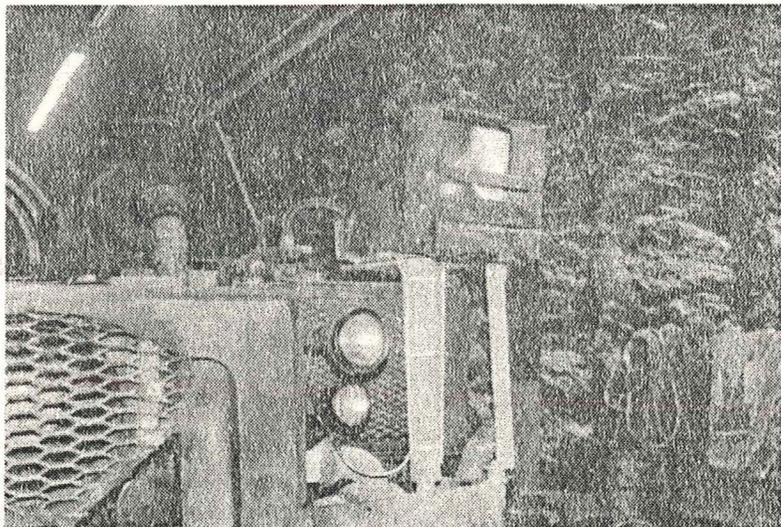


FIGURE 2.2.1-11
BAV INSTALLATION ON EIMCO LHD

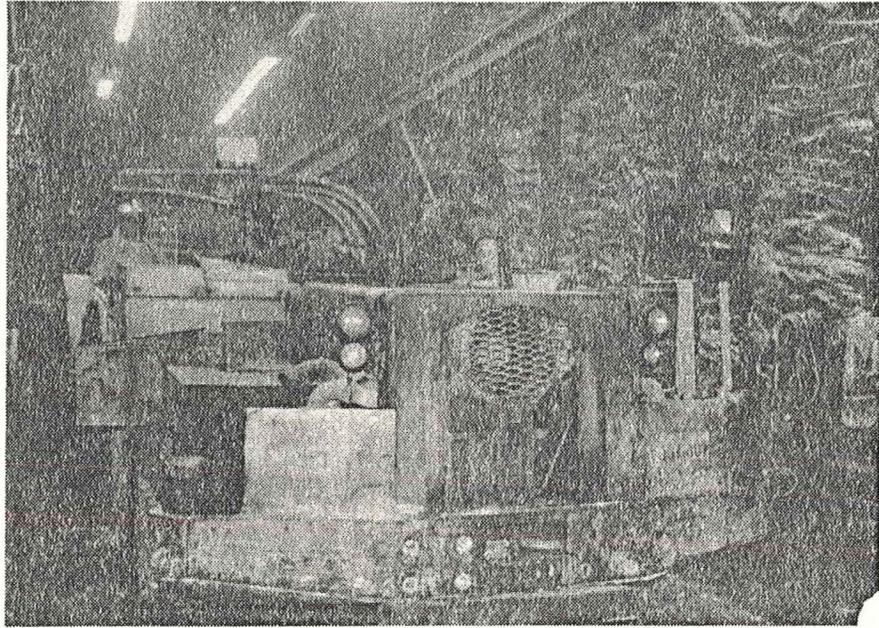


FIGURE 2.2.1-12
DRIVER'S POSITION RELATIVE TO BAV

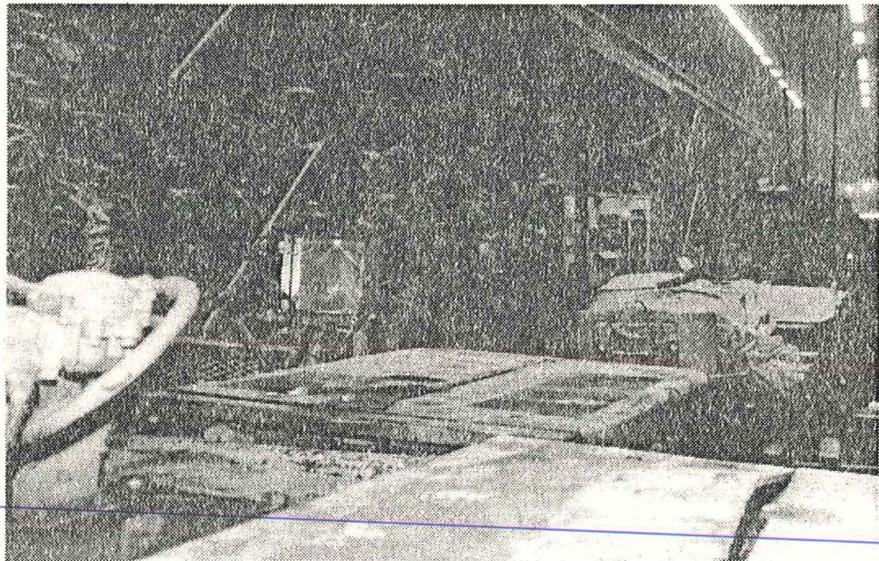


FIGURE 2.2.1-13
DRIVER'S VIEW OF BAV

2.2.2 Ozark Lead Company

At Ozark Lead Company's mine in Sweetwater Missouri the BAVs were mounted on a Wagner 21-ton truck, a Wagner 35-ton truck, a 980C Caterpillar front end loader and on a large forklift truck, all used underground. A specification sheet for a Wagner 30-ton rear dump is included in the appendix.

Figure 2.2.2-1 is a photograph showing the mounting of the BAV on a Wagner 21-ton truck (No.476). This truck had a solid fender to which was welded a bracket to enable the BAV to be mounted in a horizontal position with the louvers vertical. This directed the 70° angle of vision towards the right rear wheel where the driver had expressed the desire to be able to see.

Figure 2.2.2-2 is a photograph showing the BAV mounted on a Wagner 35-ton truck (No. 479). This truck had a three section fender with a flexible rubber section at the top. This necessitated building a bridge over the flexible section for mounting of the BAV. Figure 2.2.2-3 is a top view showing construction of this bracket arrangement. On this truck the BAV was mounted in its normal vertical upright position. For each of the installations at the Ozark Lead mine the vehicle decals were installed. These decals were designed to be used on vehicles that are equipped with blind area viewers. They descriptively illustrate the blind area viewer and its function. Figure 2.2.2-4 is a photograph showing the positioning of the decal on the Wagner trucks.

Copies of these decals are shown in Figure 2.2.2-5 and -6.

The BAV installation on the Caterpillar 980C is shown in Figures 2.2.2-7, -8 and -9 illustrating the position of the BAV, the driver's view of the BAV and the positioning of the BAV decal respectively.

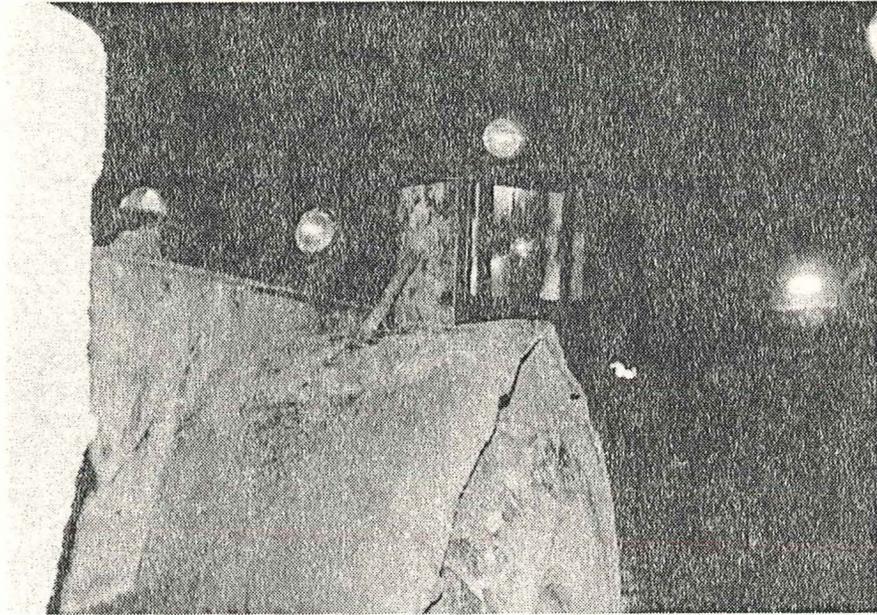


FIGURE 2.2.2-1
BAV MOUNTED ON WAGNER 21 TON TRUCK

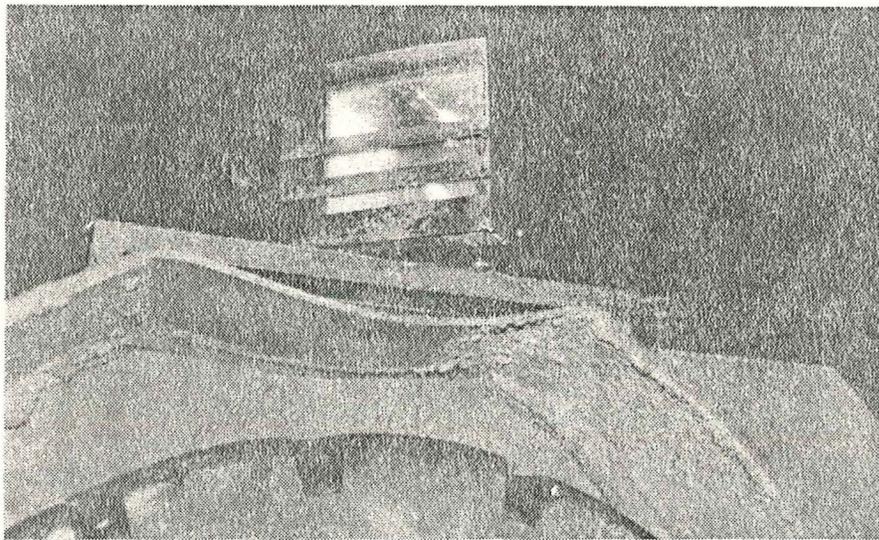


FIGURE 2.2.2-2
BAV MOUNTED ON WAGNER 35 TON TRUCK

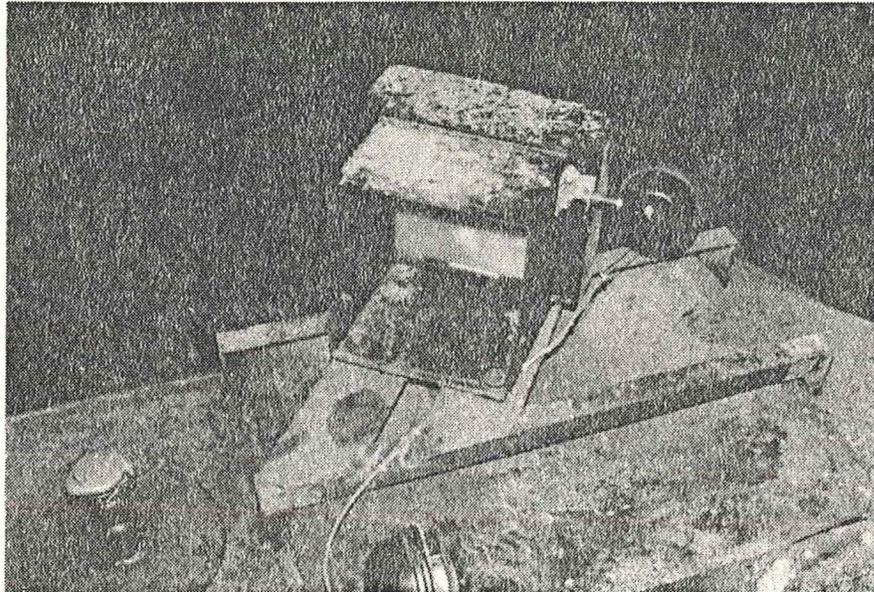


FIGURE 2.2.2-3
TOP VIEW OF BAV & MOUNTING BRACKET ON
WAGNER 35 TON TRUCK

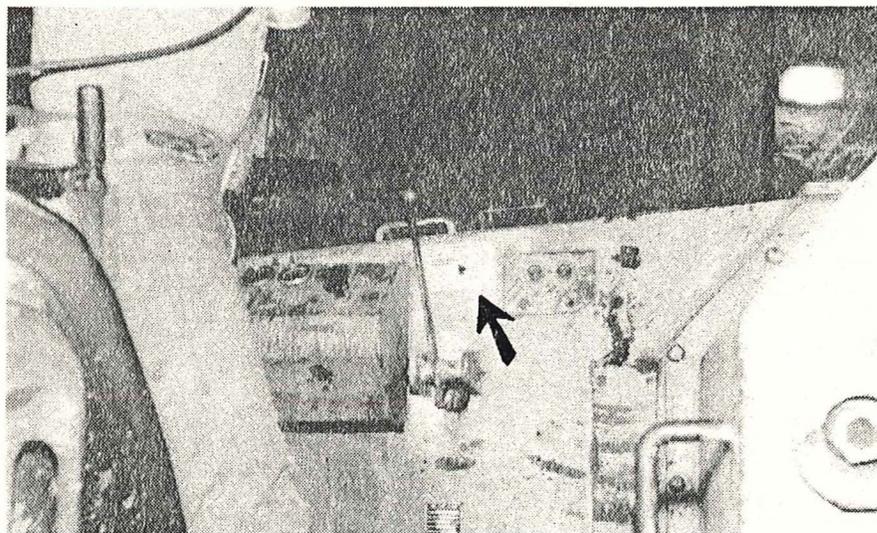


FIGURE 2.2.2-4
DECAL FOR VEHICLES WITH BAV

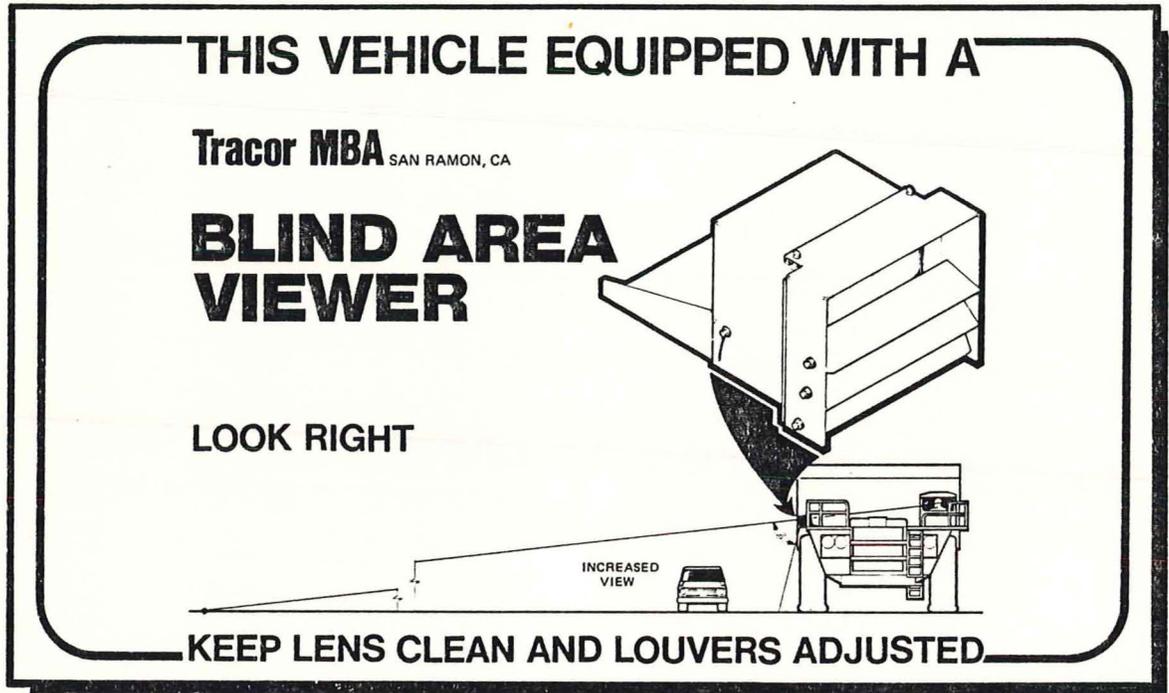


FIGURE 2.2.2-5
BAV DECAL FOR TRUCK CAB

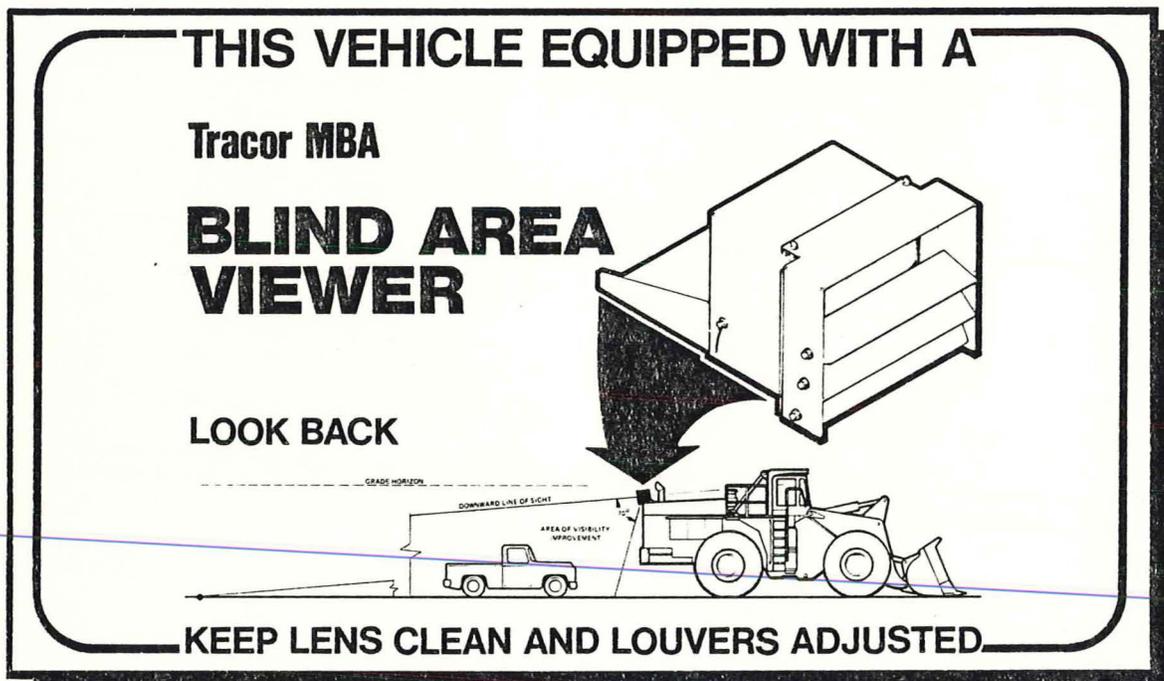


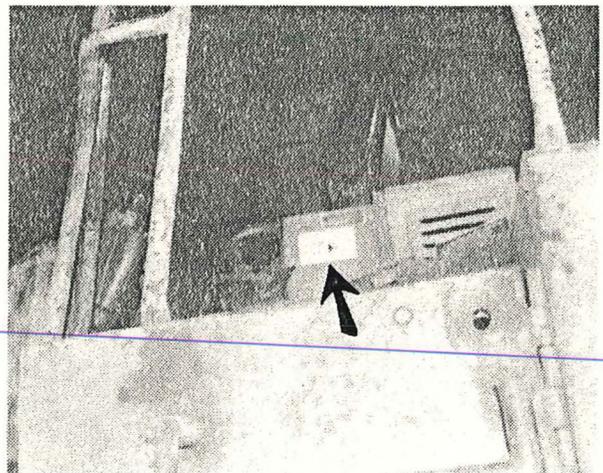
FIGURE 2.2.2-6
BAV DECAL FOR FRONT END LOADER CAB

**FIGURE 2.2.2-7
BAV INSTALLATION ON
CAT 980C FRONT END LOADER**



**FIGURE 2.2.2-8
DRIVER'S VIEW OF
BAV ON CAT 980C F.E.L.**

**FIGURE 2.2.2-9
BAV DECAL ON F.E.L.**



The BAV installation on a forklift was at the request of the forklift operator who had seen the BAV's on other equipment and had seen the USBM movie. He was interested in a better view of the area directly behind his machine.

There were no special brackets required for the installation of the BAVs on the front end loader (FEL) or the fork lift. The normal commercial mounting was used. However, since a welder was not available at the time the installation was made on the FEL, the radiator cover was removed and mounting bolts were bolted to the cover which was then replaced. The BAV was then placed on these mounting bolts. It was necessary to install the BAV within a thirty minute period shift change.

2.3 Lighting

2.3.1 International Salt Company

The lighting at International Salt Comany's mine in Cleveland Ohio was exceptionally good because of the excellent vehicle lighting and the reflection from the salt ore. However, auxiliary flood lamps were installed on the BAV to provide additional illumination to the particular area covered by the BAV. These were connected directly in parallel with the vehicle's lights and were activated at all times the vehicle was in use.

The lights used were heavy duty shock mounted tractor lamps mounted on a bracket attached directly to the BAV rear hood. These were vertical stud grounded lamps with a sealed beam (4406 par 36). They were 12.8 volts, 35 watt lamps with 80°x30° flood characteristics.

2.3.2 Ozark Lead Company

At Ozark Lead Company's mine at Sweetwater Missouri the reflecting qualities of the dark ore were very low. Therefore it was decided to use a more concentrated beam for the lights than used at the salt mine and a 4413 sealed beam unit was used. This bulb is used on self loading scrapers for illuminating the elevator which is approximately the same distance from the driver as the blind areas on the underground mining equipment.

2.4 Environmental Conditions

2.4.1 International Salt Company

The Cleveland mine of International Salt Co. was a very well kept mine. It was very clean, well maintained and the environmental conditions were excellent. The only adverse conditions were dust from the salt which was a white dust that would settle on the lens of the BAV. However, this dust was minimum and did not pose any adverse problems. The roadways were wide and well graded creating very little vibration to the vehicle or BAV.

There were no problems regarding confined space as the entries were approximately 45 feet wide and the seam being mined was 20 ft. or more in thickness. The mining method was room and pillar with 105 foot pillars.

2.4.2 Ozark Lead Company

The Sweetwater Mo. mine was typical of an average underground lead mine. In some sections there was limited overhead clearance for the large vehicles while in other sections there was practically no overhead restrictions. Some sections were quite wet and muddy while others were not. Most of the haulage ways were 50-60 ft. wide with the roadbed well maintained.

3.0 TEST RESULTS

3.1 International Salt Company

Test results at the Cleveland mine of International Salt Company indicated the BAV could be used in underground mines with little or no alterations. The relatively excellent environmental conditions in this mine did not produce a severe test for the BAVs. The relatively small amount of traffic and well controlled traffic patterns did not emphasize the full beneficial aspects of the BAV as hazardous objects were very seldom encountered, and there were very few small vehicles that possibly might park in the blind area of the test LHDs.

3.1.1 BAV Survival Rate

There were no normal mining conditions that could damage the BAV. However, one was destroyed in an accident between a vehicle and a large piece of equipment. The actual details of the accident could not be ascertained, but it was believed that in towing a drilling jumbo the boom had swung and hit the top of the BAV. This type of operation is not a normal procedure and most likely would never be repeated. The damaged BAV is shown in Figure 3.1.1-1. Its lens was badly cracked.

Another BAV was damaged slightly while it was off the machine lying in the maintenance shop when the machine was undergoing minor repair. The extent of damage was a slight deformation of the louver hood which was easily straightened and put back into use. The two used BAVs were removed from the mine after four months of use and transferred to the lead mine for further testing.

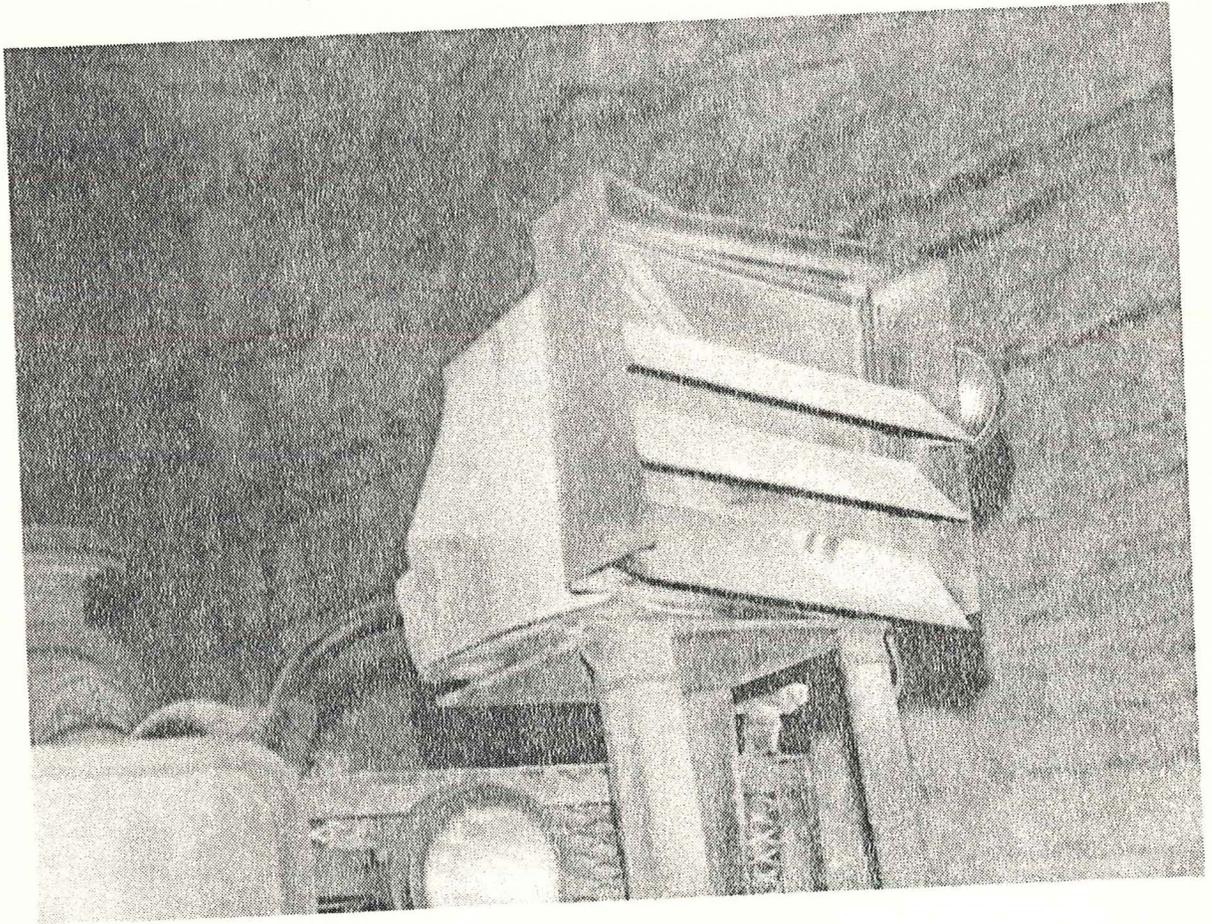


FIGURE 3.1.1-1
DAMAGED BAV ON EIMCO LHD

3.1.2 Operator's Comments

The BAVs were installed on the EIMCO LHDs in the underground maintenance department which is located near the main shaft. Thus most of the employees saw the BAVs in a well lighted area and were told about its capabilities at that time. Everyone interviewed who used the BAV on a trial basis or in actual operation appeared to be impressed with its capabilities. Some operators commented that it would certainly help in being able to see the personnel vehicles (the small golf cart type vehicle) should one be parked behind their vehicle. It was mentioned that there was a near collision of this type in the past. However, over the period of testing none of the operators reported that they were able to avoid a hazardous object by the use of the BAV. Evidently no objects were encountered by the vehicle that the operator needed to be aware of that could not be seen otherwise.

3.1.3 Safety Department's Comments

The safety department was aware of the existence of the BAV through information received from USBM publications and the movie. The movie was shown again by the maintenance supervisor to the mine manager. It was agreed that the BAV was a safety feature that could possibly be utilized on their large equipment.

3.1.4 Maintenance Department's Comments

The maintenance men had no adverse comments or objections to the BAV and appeared to be interested in its application. The maintenance supervisors were very supportive in making the test on the equipment. However, they did not believe it would be cost effective in the long run as they had not experienced accidents of the nature that could have been prevented by the use of the BAV.

To them the BAV was another piece of equipment that would have to be removed and reinstalled for major maintenance. Although it was demonstrated by the Tracor MBA representative under actual working conditions that the BAV could be removed or installed in a period of only 15 minutes, the maintenance supervisor said it would take much longer for their maintenance personnel to perform the same operation.

3.1.5 Management's Comments

The mine manager was very cooperative in permitting and assisting in this test. He also was impressed by the test results and seriously considered installing BAVs on all of their equipment as an added safety feature. However, in a management team evaluation it was determined that because of the mine's relatively accident free operation, particularly in the area where the BAV could be beneficial, it would not be cost effective to install the BAVs on their equipment.

3.1.6 Overall Evaluation

The size of the equipment in use at the Cleveland mine of International Salt Company, being relatively small in comparison to the large haulage trucks for which the BAV was designed, could not benefit greatly from the use of a BAV. Also, because of the well controlled and maintained operations at this mine and the resulting lack of accidents, that could be prevented with a BAV, the test did not demonstrate the maximum beneficial aspects of a BAV. However, the overall test results proved that the BAV could be used in underground salt mine environment without alteration.

3.2 Ozark Lead Company

3.2.1 BAV Survival Rate

The BAV mounted on the Caterpillar front end loader survived only four days of operation. The cause of the accident is not known. The louver hood was crushed, pushing the lens out the bottom. The operator reported he did not realize it had happened until sometime later and the lens could not be found. The damaged hood is shown in Figure 3.2.1-1.

The BAV that was installed on truck No. 476 had a cracked but usable lens. This was one of the BAVs transferred from International Salt Company's mine. After approximately 4 weeks of operation it was struck by the bucket of a front end loader damaging the louver hood and fracturing the lens beyond use. The louver hood was re-straightened by the maintenance shop and a new replacement lens installed. This damaged BAV is shown in Figure 3.2.1-2. The replacement BAV survived another five weeks before it was knocked off by a low hanging vent bag Y in the south end of the mine.

The replacement BAV for the one damaged on the front end loader was installed on truck No. 478 and was in operation for approximately 4 weeks. At that time it was damaged beyond use possibly by coming in contact with a sloped rib.

When the BAVs were first installed, during the dry season, the operators routinely cleaned the lens. However, a month later when the wet season approached, the mud was being thrown on the face of the BAV with each trip to the hopper. This mine is a highly productive mine with the operators on contract and thus the drivers could not be expected to take the time to clean the lens after each haulage trip. A mud flap was then designed and installed which worked well preventing the mud from splashing onto the lens. See Figure 3.2.2-1. The mud flap reportedly worked well in excluding the mud but reduced the vision next to the vehicle. The mud flap was used for approximately one week before the BAV was destroyed.

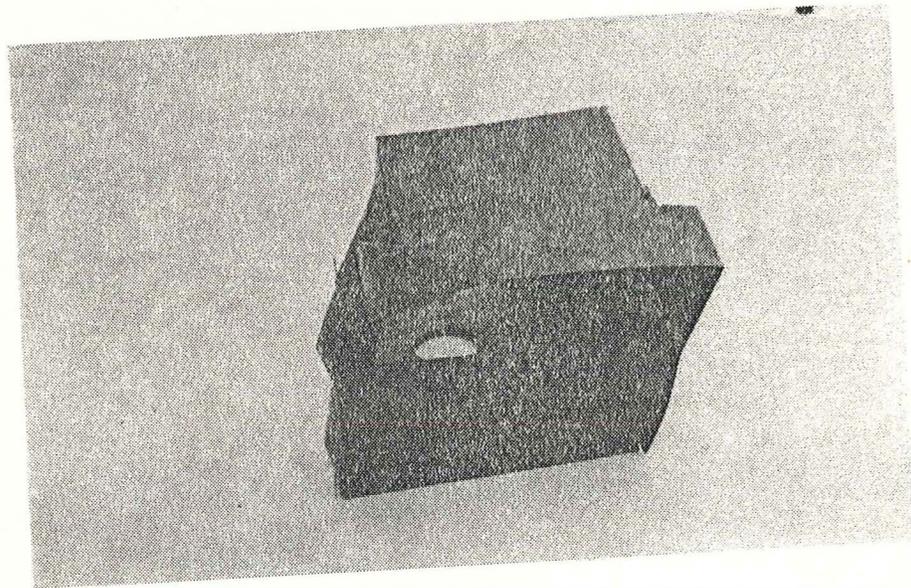
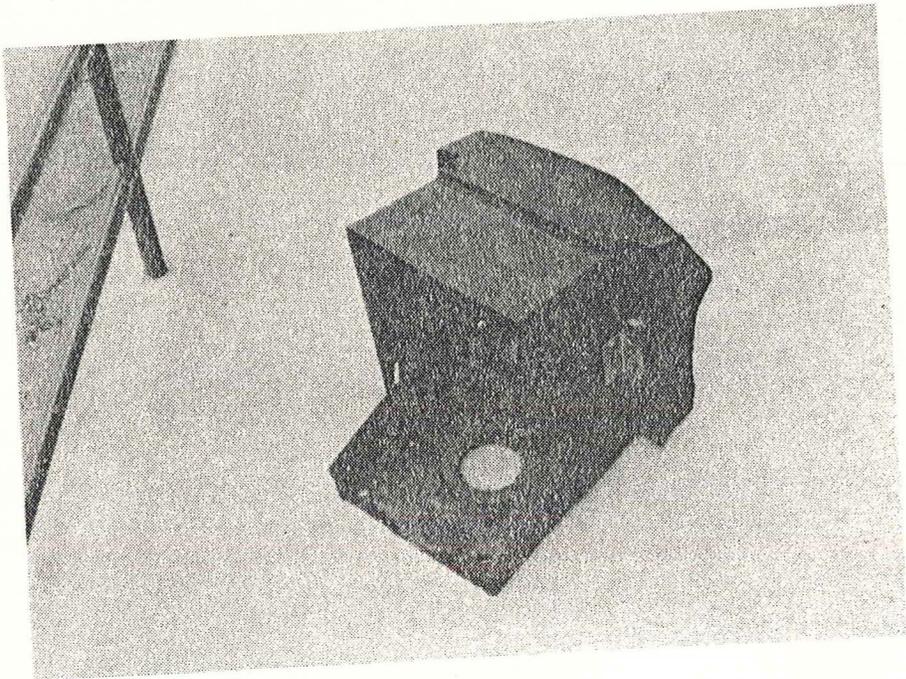


FIGURE 3.2.1-1
DAMAGED BAV REMOVED FROM CATERPILLAR FRONT END LOADER

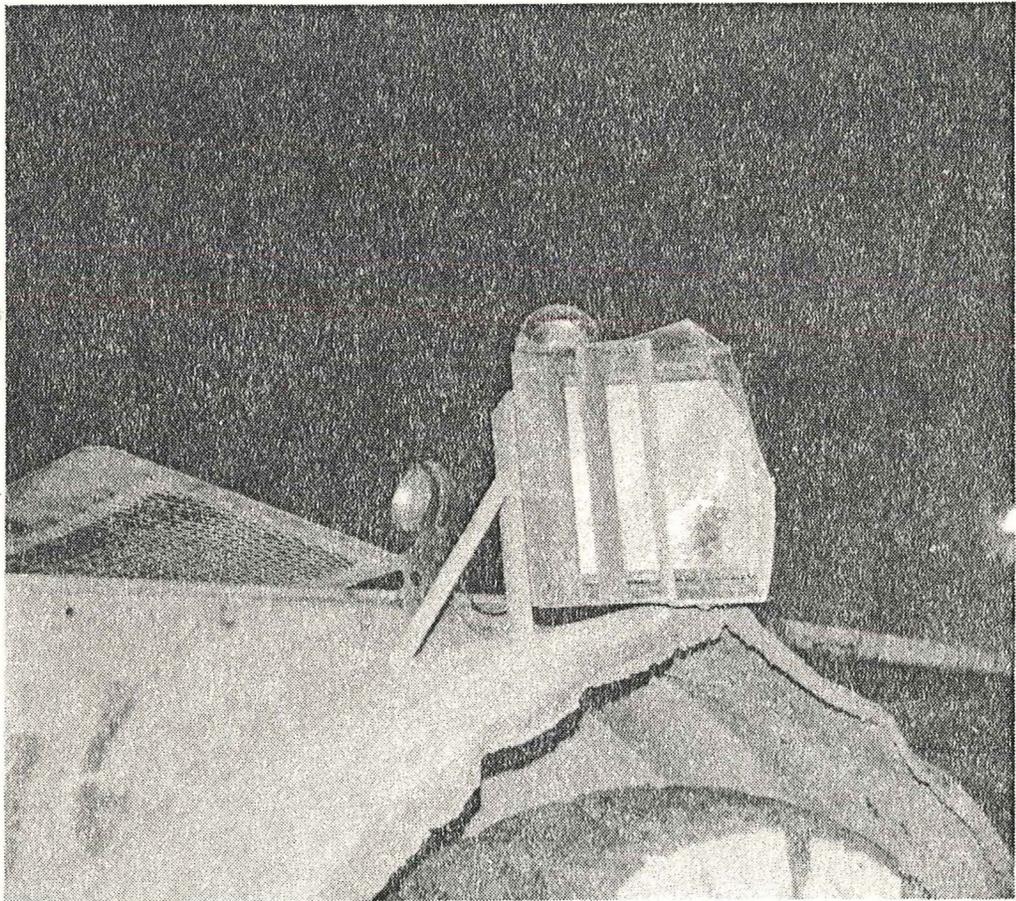


FIGURE 3.2.1-2
DAMAGED BAV ON WAGNER TRUCK

3.2.3 Safety Department's Comments

Mr. Steve Johnson, safety engineer, believed that because of the relatively low survival rate, low level light conditions and necessity to position the BAV near mud slinging tires, the use of the BAVs in their present configuration would not be sufficiently beneficial to warrant wide spread use in the Ozark Lead Mine without being redesigned.

3.2.4 Maintenance Department's Comments

The BAV mountings did not interfere with any regular maintenance areas on the vehicle, thus there were no general comments. However, it was mentioned that it was necessary to compensate for the BAV when in tight quarters as it did interfere with sliding hoses along the top of the vehicle. This occurs when lubing and fueling.

3.2.5 Management's Comments

Management was not involved except to give their approval and support for the test, thus no comments on the performance test of the BAV.

3.2.6 Overall Evaluation

The results of the testing at Ozark Lead Co. supported previous development testing. The BAVs performed well in adequately illuminated areas as long as the lens was kept clean and where objects of color contrast were viewed. The survival rate was good as long as the machines were used in sections of the mine where there was adequate overhead space. However, in sections of the mine where the overhead was minimal, the survival rate was not adequate to justify the use of the BAV. A redesign of the BAV for a lower profile in order to re-direct the light rays to allow a different mounting position (minimize mud splatter) does not appear to be feasible. The 12"x12" lens could not be much smaller and still be readily located by the operator and produce an adequate size, and desirable image.

4.0 CONCLUSIONS

It was concluded that the BAV could be useful in underground mining operations on equipment large enough to warrant its use, and where there is adequate overhead space and area lighting.

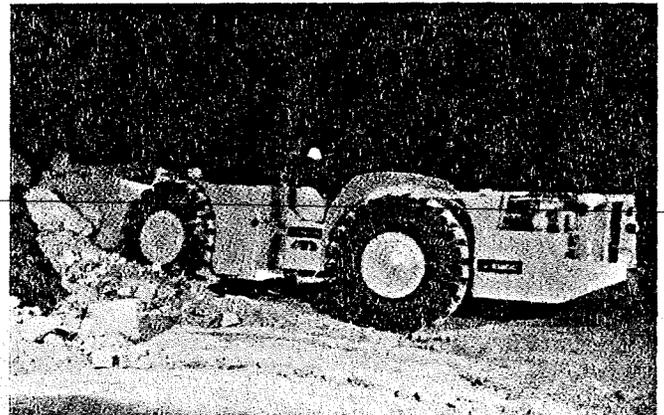
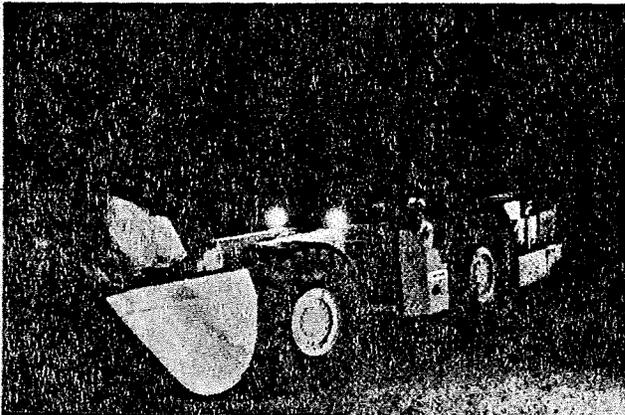
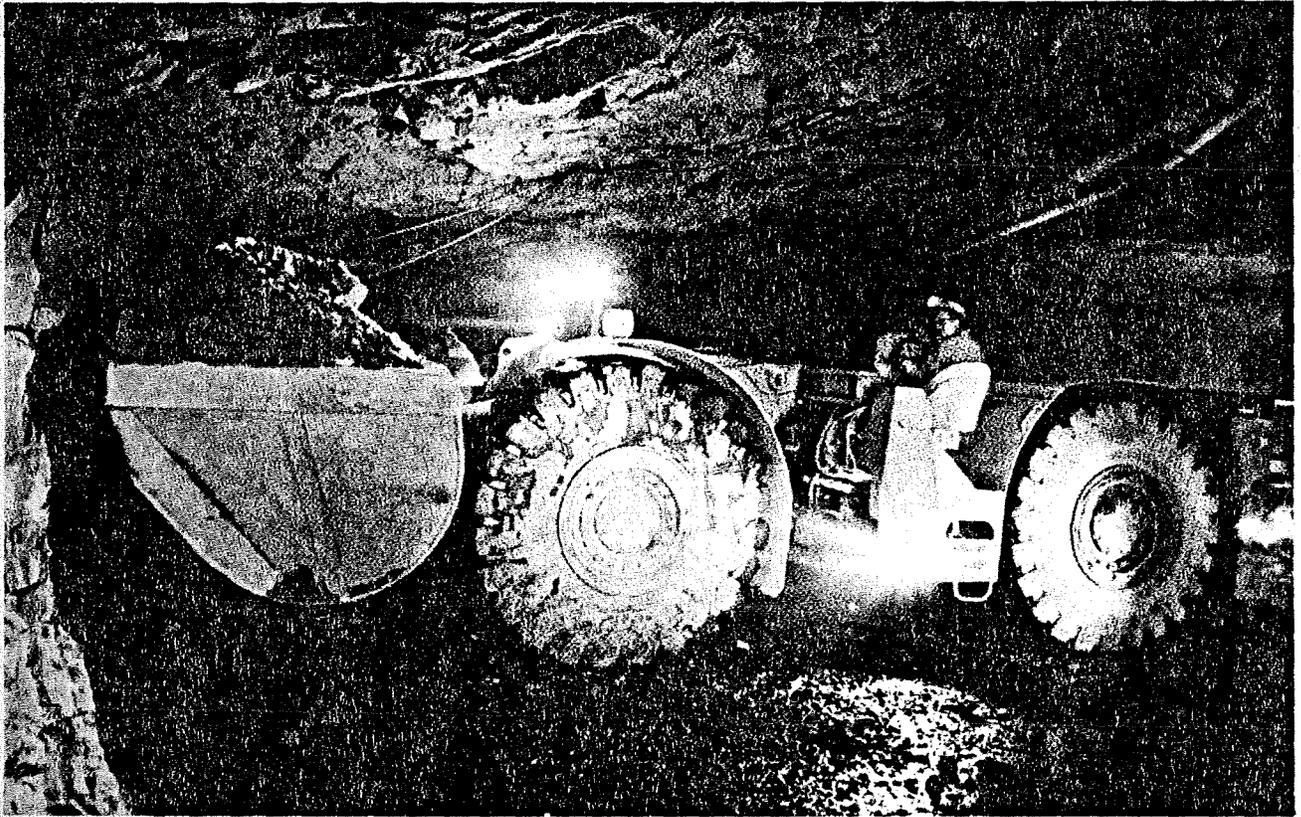
5.0 RECOMMENDATIONS

The possible use of low profile fresnel lens Blind Area Viewers should not be recommended for underground mines with low overhead space, or mines that are using medium or small equipment. The BAVs should be recommended for consideration by large mines (such as the oil shale mines in Colorado) where operations will be large enough that equipment of sufficient size and with proper lighting will be used.

APPENDIX A

EIMCO[®] 920 LHD

82 Inches High 36,000 Pound Carry Capacity





The Elmco 920 LHD Load-Haul-Dump loads up to 18 tons of muck, hauls it at speeds up to 15 mph and, with a 45° dump angle, the bucket dumps clean. Yet with all its big machine capabilities, the 920C is only 82 inches high and can operate in headings as narrow as 14 feet.

A big, powerful Caterpillar engine develops 400 hp at 2100 rpm, and can pull a full load up a 20% grade at 3 mph. The low center of gravity assures stability on those steep grades, and two separate independent air reservoir systems reduce the possibility of brake failure. Deep tread tires reinforce the grip, and no-spin differentials reduce tire-eating wheel spin so those tires will last longer.

The 18-ton capacity bucket is fabricated of heavy alloy steel plate with cast manganese steel lip, which actually becomes more wear-resistant with use. Oversize pins are used throughout.

With 60,000 pounds breakout force and 72,000 pounds of crowding power, the Elmco 920 LHD can handle any mucking job, no matter how tough, and its 6 cylinder turbocharged aftercooled power-plant and water bath exhaust conditioner require only 50,000 cfm under USBM schedule 24 standards.

The bucket boom is designed to prevent twisting or racking with a full load at full dump height.

Power-assisted controls help the operator perform all starting, steering, stopping and inching movements, and provide means for positive control over the machine at all times. Side-seating position gives equal visibility front or rear.

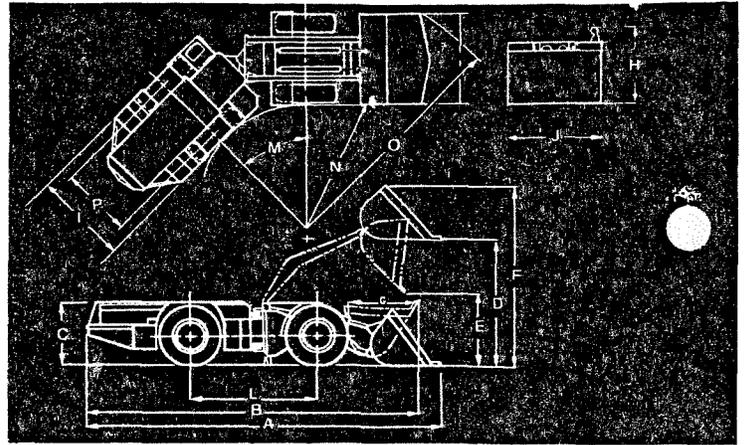
The manufacturer reserves the right to change the specifications and/or design of this vehicle at any time without notice.

STANDARD EQUIPMENT

- Electric Start
- Water Bath Exhaust Conditioner
- Spot Lights, 2 Front and 2 Rear
- Floodlights, 2 Front and 2 Rear
- Full Set Operating Gauges
- Park Brake Indicator Light
- Air Cushion Seat, Adjustable 2 ways
- Center Pivot Safety Link

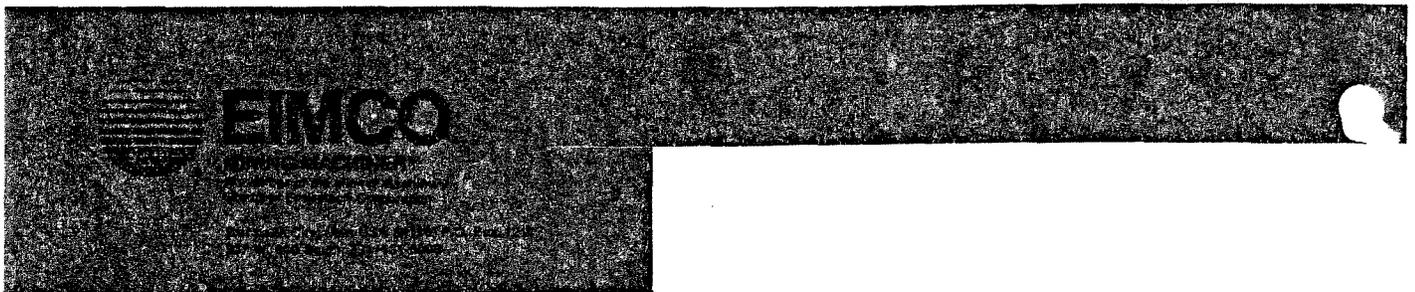
OPTIONAL EQUIPMENT

- Air Start
- Catalytic Exhaust Conditioner
- Bucket Sized to Suit
- Special Application Push-plate Bucket
- Canopy with Rollover Protection (ROPS)
- Canopy with Falling Object Protection (FOPS)
- Fire Suppression System

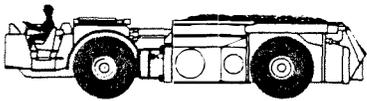


MACHINE DIMENSIONS: EIMCO 920C LHD		ENGLISH	METRIC
A.	Overall Length (Bucket down)	36 ft. 11 in.	11,252mm
B.	Overall Length (Bucket in carry position)	36 ft. 6 in.	11,125mm
C.	Overall Height (Bucket down)	6 ft. 10 in.	2083mm
D.	Dump Height (Ejector bucket)	10 ft. 6 in.	3200mm
E.	Dump Height (Rolling bucket)	6 ft. 6 in.	1981mm
F.	Height Required to Dump @ Maximum Ejector Height	17 ft.	5181mm
G.	Reach Forward to Tire (Dumping position)	6 ft.	1828mm
H.	Operator Height (Average)	7 ft. 6 in.	2286mm
I.	Maximum Machine Width	10 ft.	3048mm
J.	Maximum Width of Standard Bucket	10 ft.	3048mm
K.	Ground Clearance—Lowest Point	18 in.	457mm
L.	Wheel Base	12 ft. 6 in.	1981mm
M.	Turning Angle Right/Left	40°	
N.	Inside Turn Radius	12 ft.	3657mm
O.	Outside Turn Radius	25 ft.	7620mm
P.	Tread Gauge (Front and Rear)	7 ft. 6 in.	2286mm
WEIGHT (Operating)		94,000 lbs.	42,638kg
BUCKET OR LOADING UNIT (Standard)			
	Rated Load Capacity	36,000 lbs.	16,330kg
	Maximum Lifting Capacity (Tipping)	54,000 lbs.	119,048kg
	Breakout Force	60,000 lbs.	27,216kg
	Standard Bucket SAE Rating—Heaped*	10 cu. yd.	7.65m ³
BUCKET HYDRAULIC SYSTEM			
	Reservoir Capacity	110 gal.	416 liters
	Pump (Bucket motions)	Vane type, 150 gpm at 2100 rpm	
	Relief Valve Location	In main control valve	
	Relief Pressure	2000 psi	
	Filter	Paper element 10 microns	
	Lift Cylinder (Diameter)	9 in.	228mm
	Dump Cylinder (Diameter)	7 in.	177mm
STEERING		Full power hydraulic	
ENGINES			
	Make and Model	Caterpillar 3408 TA, watercooled	
	MSHA Rated Horsepower	400 @ 2100 rpm	
	MSHA Ventilation Requirement	48,700 cfm	1380 m ³ /min
	Make and Model	Deutz 12L413 FW, aircooled	
	MSHA Rated Horsepower	277 @ 2300 rpm	
	MSHA Ventilation Requirement	2400 cfm	680 m ³ /min
	Fuel Capacity	190 gal.	718 liters
POWER TRAIN			
	Torque Converter, Make and Model	Clark 8000 Series, single stage	
	Type	Industrial	
	Stall Torque Multiplication	3:1	
	Transmission	Clark 8000 Series	
	Speeds Forward	4	
	Speeds Reverse	4	
AXLES			
	Axles, Front and Rear	Double reduction	
	Final Reduction	Planetary wheel-ends	
	Differential	Spiral bevel with no-spin	
	Rear Axle Oscillation	20°	
BRAKES			
	Type (All Wheels)	Disc, air/hydraulic	
	Size (Diameter)	22 in. x 7 in.	559mm x 179mm
PARKING BRAKE (On drive line)		Mechanical on differential	
TIRES (Standard size), All Wheels		29.5 x 29	

*Other bucket sizes available at extra cost to suit specific application requirements.



TELETRAM[®]



PRELIMINARY
SPECIFICATIONS
FOR
MTT-426-23
4-WHEEL DRIVE
TELESCOPIC DUMP TRUCK
SPECIFICATION NO. 599531
JANUARY, 1979

CAPACITY: (PAYLOAD) MAXIMUM RATING
 U.S. Tons (2,000 Lbs. equal 1 Ton) 26 Tons
 Metric Tons (1,000 KG equal 1 Ton) 23.6 Tons

VOLUME:
 Capacity
 S.A.E. Nominal Heaped 22.5 Cu. YD. (17.2 M³)
 S.A.E. Struck 18.0 Cu. Yd. (13.8 M³)

DISCHARGING:
 Dumping Height Required 81" (2057 mm)
 Time (Approximate Minimum Time) 30 Seconds
 Distance from Center of Tires
 to Bed End 93" (2362 mm)

VEHICLE SPEEDS, LOADED:
FORWARD OR REVERSE

Gear	1st	2nd	3rd	4th
Speed in MPH	4.2	7.2	11.7	14.0
Speed in KM/H	6.8	11.6	18.8	22.3

GRADEABILITY: See Performance Curve

ENGINE:
 Deutz Diesel (4cycle), Model F10L-413FW
 SAE Schedule 24 Power Rating @ 2300 RPM
 (with fan), Maximum . . . 224 HP
 Maximum Torque @ 1500 RPM 571 Ft-Lb (78.9 MKG)
 Bore and Stroke 4.92 x 5.2 (125 mm x 132 mm)
 Number of Cylinders 10
 Displacement 973 Cu. In. (15,947 CM³)
 Cooling Air

TORQUE CONVERTER:
 Industrial Type, Single Stage w/3.09 Stall
 Torque Ratio, Model Clark C8502

TRANSMISSION:
 Full Power Shift, 4 Speeds Forward and
 4 Speeds Reverse, Model Clark 5421

AXLES:
 Front: Planetary Drive, Spiral Bevel, Full-
 Floating with Reduction in Wheel Ends.
 Clark Model 33640.
 Rear: Dead, Forged Alloy Steel Spindles,
 Heat-Treated for Maximum Durability, with
 Tapered Roller Bearings.
 Make Wagner

TIRES:
 Tubeless Nylon, Hard Rock Lug Tread Design
 w/Underground Mine Service Compound on
 Remountable Rims.
 Tire Size, Front and Rear . 21.00 x 25, 28 Ply

STANDARD BRAKES:
 Service: 4-Wheel, Straight Air
 Heavy-Duty Size 20 x 7 (508 x 178 mm)
 Parking: Spring-Applied, Air-Released

TANK CAPACITY:

	U.S. GAL.	(L)
Fuel	200	(756)
Hydraulic Fluid	100	(378)

OSCILLATION:
 Swivel - Tapered Roller Bearings
 Degree of Oscillation . . Total 10°

STEERING:
 Hydraulic Power Steering w/Monostick
 Control
 Turning Angle . . 85° (42-1/2° ea. side)
 System Pressure 1800 PSI

HYDRAULIC SYSTEM:
 Cylinders: Double-Acting w/Chrome-
 Plated Stems.
 Steering Cyl.(2), Dia. 5" (127 mm)
 1st Dump Cyl.(2), Dia. 4" (102 mm)
 2nd Dump Cyl.(1). Dia. 5" (127 mm)
 Tailgate Cyl.(2). Dia. 3" (76 mm)

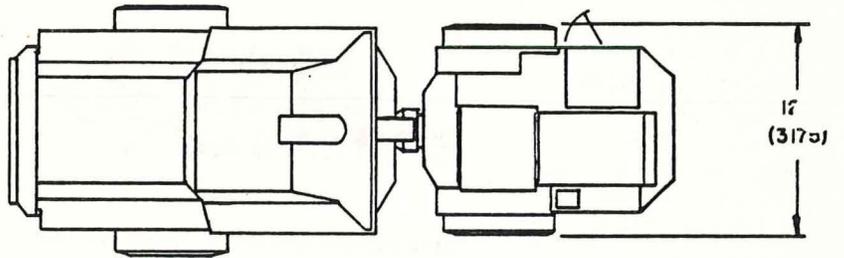
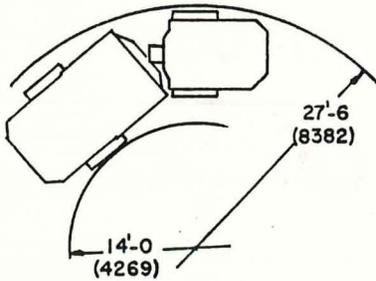
Filters:
 Return Line 33 Micron
 Suction Line 100 Mesh

Pumps: Heavy-Duty Gear Type
 Dump . . 64 GPM @2200 RPM (242 L/M)
 Steering. 42 GPM #2200 RPM (159 L/M)

OPERATOR'S ARRANGEMENT:
 Side Seating for Bi-Directional
 Trimming and Maximum Visibility

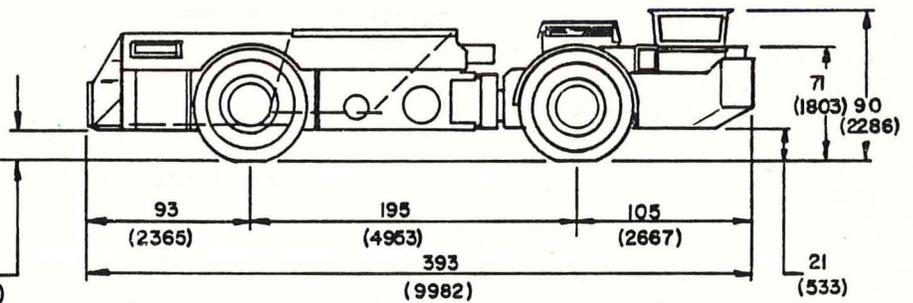
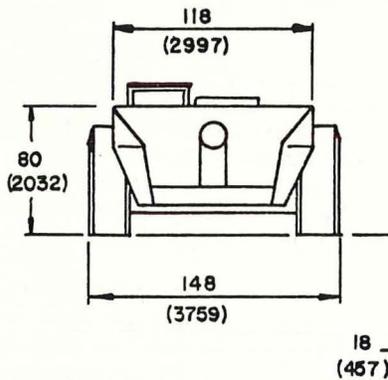
WEIGHT: (APPROXIMATE) LBS. (KG)
 Operating 53,750 (24,381)

MTT-426-23



NOTE

Dimensions in parentheses () are given in millimeters



STANDARD SPECIFICATIONS:

- Air Gauge
- Voltmeter
- Converter Pressure Gauge
- Converter Temperature Gauge
- Engine Oil Pressure Gauge
- Engine Temperature Gauge
- Converter Low Oil Pressure Alarm System
- Engine Fuel Filter
- Engine Fuel Fine Filter
- Engine Oil Filter
- Engine Oil Fine Filter
- Suction Line Filter (Hydraulic Oil)
- Return Line Filter (Hydraulic Oil)
- Transmission Oil Filter
- Air Cleaner
- Alternator

- Battery, H.D.
- Battery Isolation Switch
- Chain Drive
 - Sprockets (Case Hardened)
 - Chain (Heavy-Duty, Heat-Treated)
 - Chain Tighteners
- Converter Oil Cooler
- Converter Charging Pump
- Hydraulic Power Steering
- Lights
- Neutral Start Only
- Operator's Seat, Track-Mounted, Foam-Padded, With Adjustable Suspension.
- Safety Fuel-Shut-Off Valve
- Swivel Hinge Lock Arm
- Tailgate, Hydraulically Controlled

NOTE: This unit is designed to meet the requirements of MSHA Schedule 24

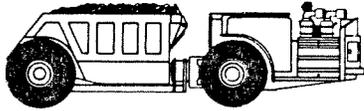
NOTE: The manufacturer reserves the right to change the specifications and/or design of this vehicle at any time without notice.



Designers and Manufacturers of Mining Equipment

For Further Information Contact:

REAR-DUMP



SPECIFICATIONS
FOR
MODEL MT-433-30
REAR DUMP TRUCK
4-WHEEL DRIVE
SPECIFICATION NO. 595550
JANUARY, 1979
DEUTZ ENGINE

P. O. BOX 20307 PORTLAND, OREGON 97220

CAPACITY:

Payload 33 Tons (29.9 Metric Tons)
Volume Semi-Heaped 22 Cu. Yds. (16.8M³)
S.A.E. Struck 18 Cu. Yds. (13.8M³)

DISCHARGING:

Time 10 Seconds

VEHICLE SPEEDS, LOADED,

ZERO GRADE, FORWARD AND REVERSE:
GEAR 1st 2nd 3rd 4th
Speed (MPH) 3.43 6.29 11.37 15.17
Speed (KM/H) (5.51) (10.12) (18.29) (24.40)

GRADEABILITY:

See Performance Curve

ENGINE:

Deutz Diesel (4 Cycle) . . . Model F12L-413FW
Maximum Power @ 2300 RPM . 277 BHP
MSHA Schedule 24 Power Rating
@2300 RPM 269 BHP
Maximum Torque @ 1500 RPM 674 FT-LB (93.2MKG)
Number of Cylinders 12V
Displacement 1168 Cu.In. (19143 CM³)
Cooling Air
Electrical System . 12/24 Volt w/24V Starter

TORQUE CONVERTER:

Single Stage With 3:1 Stall Torque Ratio
Clark Model C-8502

TRANSMISSION:

Full Power Shift, Four Speeds Forward and
Four Speeds Reverse; Clark . . Model 5420

AXLES:

Spiral Bevel Differential, Full-Floating,
Planetary Wheel End Drive, Front and Rear,
Clark Model 75,500

STANDARD BRAKES:

Service: 4-Wheel, Straight Air
Heavy-Duty Size: 20x7 in. (508 x 178MM)
Parking: Spring-Applied, Hyd-Released,
Driveline Disc Brake

TIRES:

Tubeless, Hard Rock Lug Tread Design
w/Underground Mine Service Compound
on Demountable Rims.
Size-Front and Rear: 21.00 x 25, 28 Ply

STEERING:

Articulated with Self-Aligning Thrust
Bearings, Hydraulic Rotary Servo
Actuation With Automatic Bi-Directional
Orientation.
Turning Angle 82° (41° ea. side)
System Pressure 2000 PSI

OSCILLATION:

Front Axle, Bronze Bushings
Degree of Oscillation Total 16°

HYDRAULIC SYSTEM:

Cylinders - Double-Acting With Chrome-
Plated Stems.
Steering Cyl. (2) 4.5 In. (114.3MM)
Hoist Cyl. (2) Telescopic 7.5 In. (190.5MM)
Pumps - Heavy-Duty Gear Type
Dump 86 GPM (326 L/Min.) @2300 RPM
Steering 43 GPM (162 L/Min.) @2300 RPM
Filter
Suction Line 30 Micron

CAPACITIES:

	U.S. GAL.	(LITER)
Fuel Tank	128	(484)
Hydraulic Tank	133	(503)

EXHAUST CONDITIONER:

Catalytic Purifier

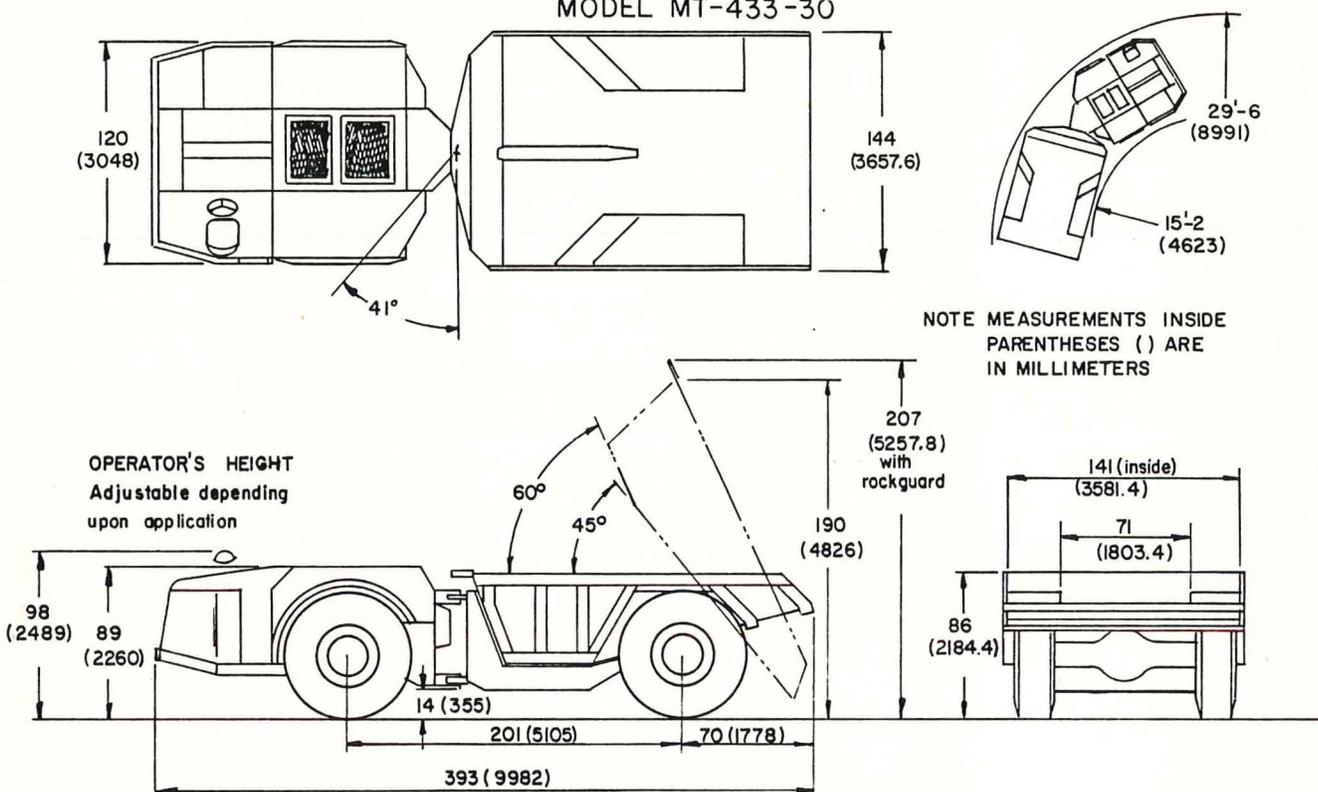
OPERATOR'S ARRANGEMENT:

Side Seating for Bi-Directional Operation
and Maximum Visibility

WEIGHT: (APPROXIMATE)

	LBS.	(KG)
Operating	61,890	(28,068)

MODEL MT-433-30



NOTE MEASUREMENTS INSIDE PARENTHESES () ARE IN MILLIMETERS

OPERATOR'S HEIGHT
Adjustable depending
upon application

STANDARD EQUIPMENT

Air Pressure Gauge
Voltmeter
Engine Hour Meter
Engine Oil Pressure Gauge
Engine Temperature Gauge
Converter/Transmission
Pressure Gauge
Converter/Transmission
Temperature Gauge
Converter Charging Pump
Converter Oil Cooler
Fuel/Water Separator
Engine Primary Fuel Filter
Engine Secondary Fuel Filter

Engine Primary Oil Filter
Engine Secondary Oil Filter
Suction Line Filter
(Hydraulic Oil)
Transmission Oil Filter
Hydraulic Power Steering
Air Cleaner, Dry Type
Alternator
Batteries, H.D. (2)
Battery Isolation Switch
Lights
Neutral Start Protection
Low Converter Oil Pressure/
High Temp. Audio-Visual
Alarm System

Fuel Shut-Off Valve
Swivel Hinge Lock Arm
Operator's Seat, Track-Mounted
Foam-Padded
Catalytic Exhaust Purifier

The manufacturer reserves the right to change the specifications and/or design of this vehicle at any time without notice.

For Further Information Contact:



Designers and Manufacturers
of Mining Equipment