Informational Report 1035

Field Evaluation of a Proximity Alarm Device

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by

Richard L. Reynolds[1]

ABSTRACT

This report examines the use of a proximity warning device on a crane boom to provide a warning when the boom approaches a predetermined safe distance from an energized powerline. The purpose of this study was to determine the sensitivity and ruggedness of the device under field operating conditions.

INTRODUCTION

In the past, industry as a whole and the mining industry in particular have been faced with the hazard of bare high voltage lines in the vicinity of work areas. These lines were not a hazard until a crane or similar type of equipment containing a boom or mast was brought into the work area. In spite of the efforts of the equipment operators, the boom or masts of their equipment, on occasion, would strike the overhead lines. In the past 2 years the mining industry has experienced four electrocutions from such accidents.

Because of these electrocutions MESA's Coal Mine Health and Safety requested Technical Support to evaluate a proximity alarm device which could give a warning and thus prevent such accidents.

The proximity alarm device, which was evaluated, is known as "Sigalarm."[2] The purpose of the evaluation was to determine--

1. If the device would operate properly in the mining environment for an extended period of time, and

2. If it needed any design changes to produce the margin of safety necessary to prevent future electrocutions resulting from contact of equipment with high voltage lines.

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[1]Chief, Mine Electrical Systems Group.

[2]Reference to specific brands, equipment, or trade names in this report is made to facilitate understanding and does not imply endorsement by the Mining Enforcement and Safety Administration.

ACKNOWLEDGMENTS

The assistance of Fred Williams and Lemoyne Morris of Coal Mine Health and Safety, District 8, in conducting this evaluation is greatly appreciated. Thanks are also due to Mr. Henry Gilham of Consolidation Coal Company for providing the crane and manpower for the device installation, and to Mr. Eldon Heither of Heither Associates, Incorporated, for providing the proximity alarm device.

FIELD TESTS

On October 25, 1973, a "Sigalarm" system was installed on a Bucyrus Erie Hydrocrane for evaluation. The crane was located at the Electric Shop of the Central Division of Consolidation Coal Company. The following people were present during the installation and tests:

Consolidation Coal Company

Henry Gilham
Tom Russiello
Sam Hartley
Ivan Coleman

Heither Associates, Inc.

Sam Midkiff

Bower Industries, Inc.

Arthur C. Gregr

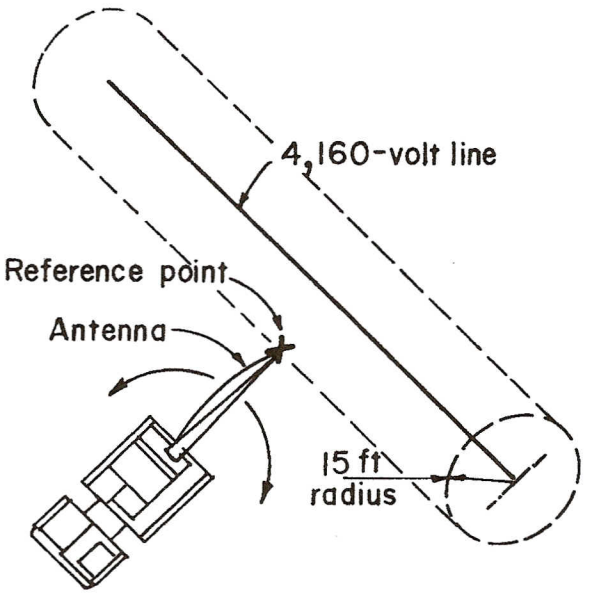
MESA

John Greenhalgh	Coal Mine Health and Safety
Roy Jones	Coal Mine Health and Safety
Fred Williams	Coal Mine Health and Safety
Richard Reynolds	Pittsburgh Technical Support Center

The following tests were conducted to determine the sensitivity of the device under simulated working conditions (see appendix I).

Radial Swing Test

After the initial installation of the "Sigalarm," the crane was positioned approximately 50 feet away from a 4,160 volt distribution line, which was about 25 feet above the ground. The sensitivity was set to detect the high voltage line when the boom was at a reference point approximately 15 feet from the line. The boom was then swung clockwise and counterclockwise from the reference position (see figure 1, Radial Swing Test).



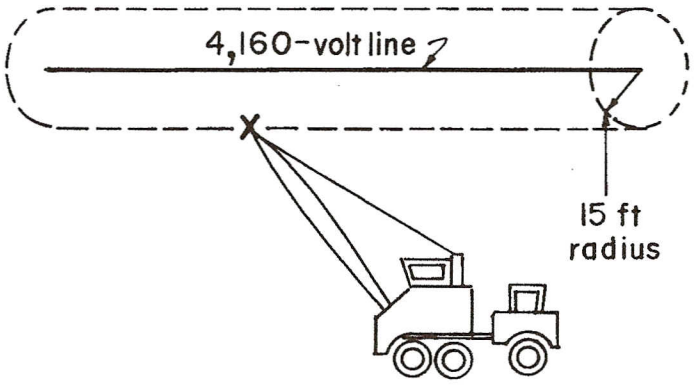
RADIAL SWING TEST
(Boom below but not under line)
FIGURE 1. - Radial swing test.

This test was performed to determine the ability of the warning device to repeat its signal within a reasonable distance from the reference point. It was found that while swinging the boom from either direction toward the reference point, the device would produce a warning when within 1 foot of the reference point.

Vertical Lifting Test

With the boom of the crane at the same reference point as in the radial test, the boom was lowered and raised vertically. In this test the alarm produced a warning within 1 foot of the reference point. (See figure 2, Vertical Lifting Test.)

In this test, it was noted that, although the antenna for the detection circuit was along the crane boom, the boom did not appreciably shield the antenna from the electrostatic field of the energized lines during the test.



VERTICAL LIFTING TEST
(Boom under line)
FIGURE 2. - Vertical lifting test.

Boom Extension Test

The crane on which the "Sigalarm" was installed had an extendable boom (see appendix II). As the boom was extended the antenna became longer and changed the sensitivity setting of the device. Therefore, a test was designed to detect the effect of setting the sensitivity with the boom extended and then operating the crane with the boom contracted. For this test the boom was extended in a parallel position to a 66 kv line which was approximately 120 feet away, as shown in figure 3.

At this point, the sensitivity of the device was set so that a warning was barely detectable. Next the boom was contracted and swung toward the lines until a warning was again detectable as in figure 4.

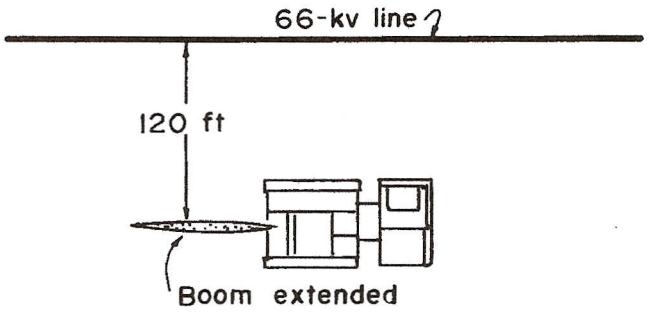


FIGURE 3. - Boom extension test, extended.

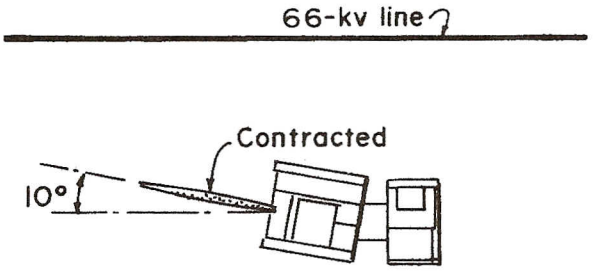


FIGURE 4. - Boom extension test, contracted.

The results of this type of test can be very illusive depending on the percentage of change in antenna length as the boom is extended and contracted. In the test described, the boom was moved through a 10° arc toward the lines before a warning was given. This situation has the inherent good feature that the boom is always shorter when the sensitivity is reduced. However, the operator should be cautioned to always reset the sensitivity when the boom length is changed.

Multiple Lines Test

It is not unusual to find several powerlines on the property where a crane may be working. Therefore, for this test the crane was positioned between two powerlines which were approximately 150 feet apart, as shown in figure 5.

In this situation, it was found that the device could not practically be adjusted to detect the 110 v line. This was because the electric field of the 66 kv was much larger than the field of the 110 v line at the chosen position in the crane work area. Because of this, extra caution should be exercised in using the devices between two powerlines.

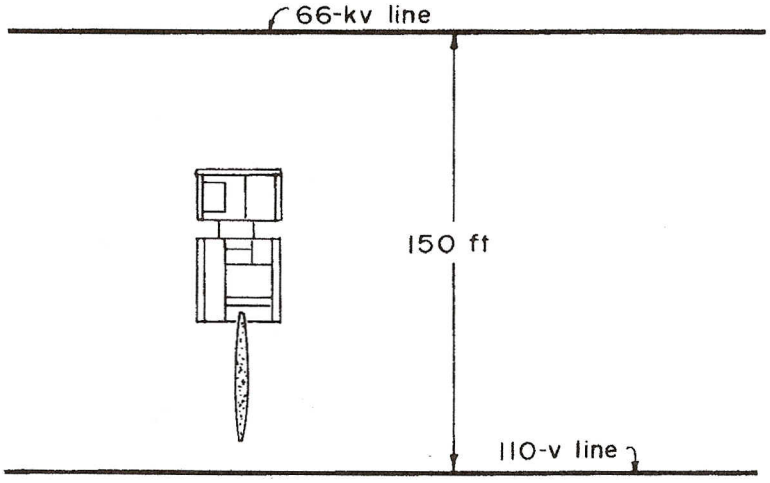


FIGURE 5. - Multiple lines test.

OBSERVATIONS

The following observations were made during installation and field tests:

1. By placing the antenna along the boom and spacing it approximately 8 inches above the boom structure, there is no appreciable shielding of the antenna by the boom.

2. The device gave consistent results during the test. It produced a

warning within 1 foot of the set point regardless of the direction of boom movement as was demonstrated in the vertical and radial tests.

3. The device did hold up under vibration and varying weather conditions to which it was submitted.

4. It was accepted favorably by the two crane operators at the mine.

5. The operator of a crane with an extendable boom should be aware that the device is less sensitive when the boom is not extended.

6. When the crane is operated between two powerlines, that are transmitting at different voltage levels, it is possible that the device could be keying on the higher voltage line when the more immediate hazard is the lower voltage line.

CONCLUSIONS

When this particular device is used on an extendable boom the crane operator must adjust its sensitivity and be very familiar with its limitations before he begins to rely on it for warnings. In no case should the device be used to indicate when the boom is actually in a dangerous position, that is, 1 foot from a 66 kv line. The device should be used to warn the operator when the boom of the crane penetrates the safe limits as set forth in the Title 30, Code of Federal Regulations, Section 77.907-2 (see appendix III).

The following are some desirable design changes which would improve the device's operation:

1. The device should be energized automatically when the crane is readied for operation.

2. The device should automatically set itself for maximum sensitivity when it is energized. This would necessitate the operator adjusting it for proper operation and prevent him from forgetting to make the adjustment.

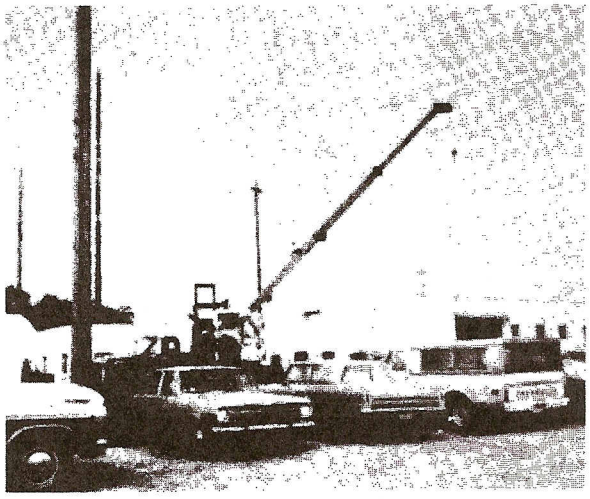
Field tests for a period of 6 months demonstrated that the device is rugged enough for mine use and that it does, indeed, operate with very good reliability. If installed on equipment with masts and booms, it will alert the operators of such equipment to the hazards of overhead lines and has the potential to prevent contact electrocutions and save lives in the future.

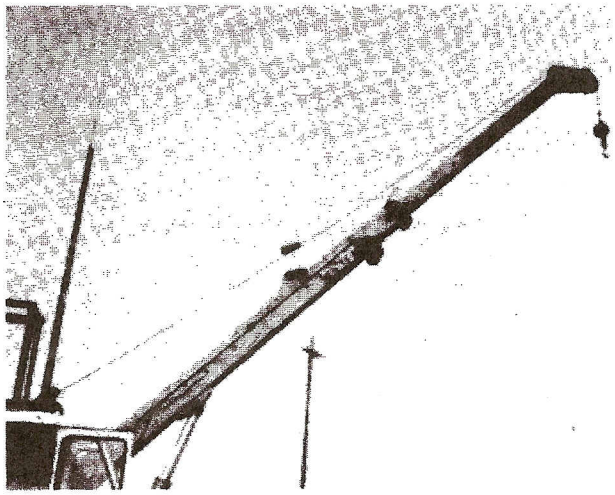
It also has the capability of automatically stopping a machine function such as boom swing, boom elevate, and boom extend if the operator fails to heed the audible warning.

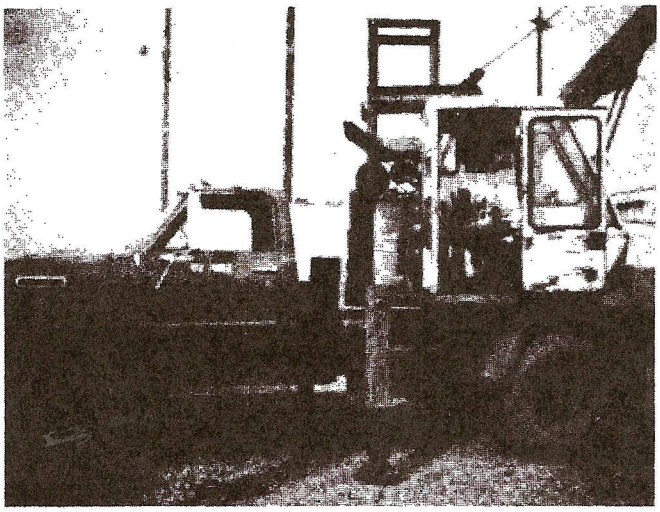
APPENDIX I

Test	Powerline voltage	Distance to powerline from reference point	Number of trials
Radial swing test.....	4,160 v	15 feet	4
Vertical lifting test.....	4,160	15 feet	4
Boom extension test.....	66 kv	120 feet	3
Multiple lines test.....	66 kv	145 feet	4
	110 v	10 feet	4

APPENDIX II







APPENDIX III

77.807-2 Booms and masts; minimum distance from high-voltage lines.

The booms and masts of equipment operated on the surface of any coal mine shall not be operated within 10 feet of an energized overhead powerline. Where the voltage of overhead powerlines is 69,000 volts, or more, the minimum distance from the boom or mast shall be as follows:

Nominal powerline voltage (in 1,000 volts)	Minimum distance (feet)
69-114	12
115-229	15
230-344	20
345-499	25
500 or more	35

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