



NIOSH

ALERT

MAY 1995

REQUEST FOR ASSISTANCE IN

Preventing Electrocutions of Crane Operators and Crew Members Working Near Overhead Power Lines



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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Request for Assistance in

Preventing Electrocutions of Crane Operators and Crew Members Working Near Overhead Power Lines

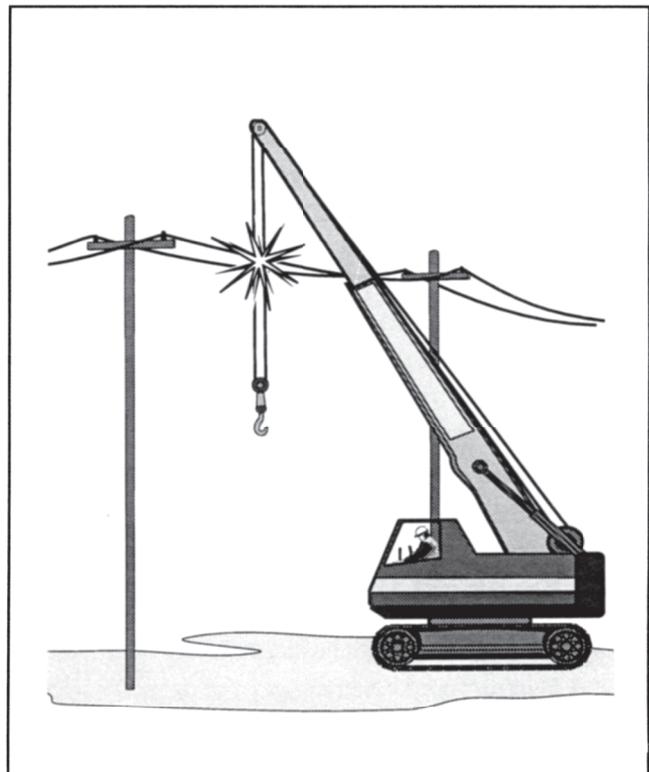
WARNING!

Crane operators and crew members may be electrocuted when they work near overhead power lines.

The National Institute for Occupational Safety and Health (NIOSH) requests assistance in preventing electrocutions of crane operators and crew members working near overhead power lines. Recent NIOSH investigations suggest that employers, supervisors, and workers may not be fully aware of the hazards of operating cranes near overhead power lines or may not implement the proper safety procedures for controlling these hazards. This Alert describes five cases (six electrocutions) that resulted from such hazards and makes recommendations for preventing similar incidents. The Alert updates a previous NIOSH Alert published in July 1985 [NIOSH 1985].

The recommendations in this Alert should be followed by all employers, managers, supervisors, and workers in companies that use cranes or similar boomed vehicles. NIOSH requests that the following individuals and organizations bring this Alert to the attention of workers who are at risk: editors of trade journals, safety and health officials, construction companies, unions, suppliers and

manufacturers of building materials, crane manufacturers, electric utilities, and others who use cranes or boomed vehicles.



Workers are killed each year when cranes contact overhead power lines.

BACKGROUND

NTOF Data

Data from the NIOSH National Traumatic Occupational Fatalities (NTOF) Surveillance System indicate that electrocutions accounted for approximately 450 (7%) of the 6,400 work-related deaths from injury that occurred annually in the United States during the period 1980–89 [NIOSH 1993a]. Each year an average of 15 electrocutions were caused by contact between cranes or similar boomed vehicles and energized, overhead power lines. The actual number of workers who died from crane contact with energized power lines is higher than reported by NTOF because methods for collecting and reporting these data tend to underestimate the total number of deaths [NIOSH 1993a]. More than half of these crane-related electrocutions occurred in the construction industry.

FACE Data

From 1982 through 1994, NIOSH conducted 226 onsite investigations of work-related electrocutions under the Fatality Assessment and Control Evaluation (FACE) Program. Twenty-nine (13%) of these incidents (which resulted in 31 fatalities) involved crane contact with overhead power lines. Nearly half of the incidents occurred in the construction industry. Because the FACE investigations were conducted in only 16 states, these fatalities represent only a portion of the crane-related electrocutions during the period 1982–94.

OSHA Data

A study conducted by the Occupational Safety and Health Administration (OSHA) showed that 377 (65%) of 580 work-related

electrocutions occurred in the construction industry during the period 1985–89 [OSHA 1990]. Nearly 30% (113) of these electrocutions involved cranes.

CURRENT STANDARDS

OSHA Regulations

Current OSHA regulations require employers to take precautions when cranes and boomed vehicles are operated near overhead power lines. Any overhead power line shall be considered energized unless the owner of the line or the electric utility company indicates that it has been de-energized and it is visibly grounded [29 CFR 1926.550 (a)(15)(vi)]. The OSHA regulations are summarized as follows:

- Employers shall ensure that overhead power lines are de-energized or separated from the crane and its load by implementing one or more of the following procedures:
 - De-energize and visibly ground electrical distribution and transmission lines [29 CFR 1910.333(c)(3); 29 CFR 1926.550(a)(15)]
 - Use independent insulated barriers to prevent physical contact with the power lines [29 CFR 1910.333(c)(3); 29 CFR 1926.550(a)(15)]
 - Maintain minimum clearance between energized power lines and the crane and its load [29 CFR 1910.333(c)(3)(iii); 29 CFR 1926.550(a)(15)(i), (ii), (iii)].

**Code of Federal Regulations. See CFR in references.*

- Where it is difficult for the crane operator to maintain clearance by visual means, a person shall be designated to observe the clearance between the energized power lines and the crane and its load [29 CFR 1926.550(a)(15)(iv)].
- The use of cage-type boom guards, insulating links, or proximity warning devices shall not alter the need to follow required precautions [29 CFR 1926.550 (a)(15)(v)]. These devices are not a substitute for de-energizing and grounding lines or maintaining safe line clearances.

ANSI Standard

The American National Standards Institute (ANSI) has published a standard for mobile and locomotive cranes that includes operation near overhead power lines [ANSI 1994]. This consensus standard (B30.5–1994) contains guidelines for preventing contact between cranes and electrical energy. The standard addresses the following issues:

- Considering any overhead wire to be energized unless and until the person owning the line or the utility authorities verify that the line is not energized
- De-energizing power lines before work begins, erecting insulated barriers to prevent physical contact with the energized lines, or maintaining safe clearance between the energized lines and boomed equipment
- Limitations of cage-type boom guards, insulating links, and proximity warning devices
- Notifying line owners before work is performed near power lines

- Posting warnings on cranes cautioning the operators to maintain safe clearance between energized power lines and their equipment

CSA Recommendations

The Construction Safety Association of Ontario, Canada (CSA) recommends safe work practices in addition to those addressed in the OSHA and ANSI standards [CSA 1982]. These recommendations include the following.

Work Practices

- Operate the crane at a slower-than-normal rate in the vicinity of power lines.
- Exercise caution near long spans of overhead power lines, since wind can cause the power lines to sway laterally and reduce the clearance between the crane and the power line.
- Mark safe routes where cranes must repeatedly travel beneath power lines.
- Exercise caution when travelling over uneven ground that could cause the crane to weave or bob into power lines.
- Keep all personnel well away from the crane whenever it is close to power lines.
- Prohibit persons from touching the crane or its load until a signal person indicates that it is safe to do so.

The CSA recommendations also address the limitations of proximity warning devices, hook insulators, insulating boom guards, swing limit stops, nonconductive taglines, ground rods, and similar devices for protection against electrical hazards.

Procedures to Follow If Contact Occurs

To protect against electrical shock injury in the event of contact between a crane and an energized line, the CSA recommends the following:

- The crane operator should remain inside the cab.
- All other personnel should keep away from the crane, ropes, and load, since the ground around the machine might be energized.
- The crane operator should try to remove the crane from contact by moving it in the reverse direction from that which caused the contact.
- If the crane cannot be moved away from contact, the operator should remain inside the cab until the lines have been de-energized.

CASE REPORTS

The five cases presented here were investigated by the NIOSH FACE Program between March 1990 and March 1993.

Case No. 1—One Death

On March 1, 1990, a 29-year-old worker was electrocuted when he pushed the crane cable on a 1-yard cement bucket into a 7,200-volt power line. The victim was a member of a crew that was constructing the back concrete wall of an underground water-holding tank at a sewage treatment plant. Before work on the tank began, the company

safety director made sure that insulated line hoses were placed over sections of the power line near the jobsite and that a safe clearance zone was marked off for arriving cement trucks to use for loading their cement buckets.

After the wall was poured, the driver of the cement truck cleaned the loading chute on his truck with a water hose mounted on the truck. As he began to pull away, the crew supervisor yelled to him, asking if the crew could use his water hose to wash out the cement bucket suspended from the crane. The driver stopped the truck under the power line and the crane operator (not realizing that the truck had been moved) swung the boom to position the bucket behind the truck. The victim grasped the handle of the bucket door and pushed down to open it, bringing the crane cable into contact with the power line. The victim provided a path to ground and was electrocuted [NIOSH 1990b].

Case No. 2—One Death

On August 11, 1990, a 33-year-old well driller was electrocuted when a metal pipe lifted by a truck-mounted crane contacted a 12,000-volt overhead power line. The victim and a coworker were repairing a submersible pump for a water well at a private residence. The well was located in a pasture with three parallel power lines overhead. One of the power lines passed directly over the well (32 feet above the ground). On the day of the incident, the victim positioned the truck-mounted crane beneath the power line. Using a handheld remote-control pendant, the victim fully extended the end of the boom 36 feet above the ground. The crane cable was attached to a 1-inch-diameter galvanized pipe that ran to the pump inside the well. As the victim raised the pipe, it contacted the power line directly above the well, energizing the crane and the handheld

remote-control pendant. The victim provided a path to ground and was electrocuted [NIOSH 1990c].

Case No. 3—One Death

On August 22, 1990, a 24-year-old foreman for a telecommunications company was electrocuted when he grabbed the door handle on a truck-mounted crane whose boom was in contact with a 7,200-volt overhead power line. The foreman and three other workers (a lineman, a cable splicer, and a laborer) were attempting to remove four poles that had supported a billboard. The poles stood 20 feet high and were buried 5 feet in the ground. They were located 15 feet away from (and parallel to) the power line. To remove the poles, the lineman positioned the crane directly under the power line. He controlled the crane boom while standing on the ground using rubber-coated hand controls mounted on the back of the truck. The poles were removed by hooking the crane boom cable around the middle of each pole and vertically pulling each pole out of the ground. While the workers were pulling out the third pole, the end of the boom contacted the overhead power line. The laborer (who was working in the back of the truck) noticed that the lineman was being shocked and was unable to let go of the hand control. The laborer kicked the lineman in the chest and the lineman fell unconscious to the ground. He revived without assistance about 3 minutes later with electrical burns to his left hand. However, the crane boom remained in contact with the power line, the truck tires ignited, and the truck began to burn. When the foreman noticed that the boom remained in contact with the power line, he tried to open one of the truck doors (presumably to move the truck). When his hand contacted the door handle, he provided a path to ground and was electrocuted [NIOSH 1990a].

Case No. 4—One Death

On June 24, 1991, a 37-year-old construction laborer was electrocuted while pulling a wire rope attached to a crane cable toward a load. The choker was to be connected to a steel roof joist that was to be lifted 150 feet across the roof of a one-story school and set in place. The cab of the crane was positioned 11 feet 6 inches from a 7200-volt power line. After a previous roof joist had been set in place, the crane operator swung the crane boom and cable back toward the victim, who grabbed the choker in his left hand. With his right hand, he held onto a steel rod that had been driven into the ground nearby. At this point, the momentum of the swinging crane apparently caused the crane cable to contact the power line. The electrical current passed across the victim's chest and through the steel rod to ground, causing his electrocution [NIOSH 1991].

Case No. 5—Two Deaths

On March 31, 1993, a 20-year-old male truck driver and his 70-year-old male employer (the company president) were electrocuted when the boom of a truck-mounted crane contacted a 7,200-volt conductor of an overhead power line. The incident occurred while the driver was unloading concrete blocks at a residential construction site. The driver had backed the truck up the steeply sloped driveway under a power line at the site and was using the crane to unload a cube of concrete blocks. The company president and a masonry contractor watched as the driver operated the crane by a handheld remote-control unit. The driver was having difficulty unloading the blocks because the truck was parked at a steep angle. While all three men watched the blocks, the tip of the crane boom contacted a conductor of the overhead power line and completed a path to ground through the truck, the remote control unit,

and the driver. The company president attempted to render assistance and apparently contacted the truck, completing a path to ground through his body. He died on the scene. The truck driver was airlifted to a nearby burn center where he later died as a result of electrical burns [NIOSH 1993b].

CONCLUSIONS

These case reports indicate that some crane operators, their employers and supervisors, and others who work around cranes may not be fully aware of the hazards of operating cranes near overhead power lines or may not implement the proper safety procedures for controlling these hazards.

RECOMMENDATIONS

NIOSH recommends that employers take the following measures to protect workers and operators of cranes and other boomed vehicles from contacting energized overhead power lines.

Comply with OSHA Regulations

- Train workers to comply with current OSHA regulations. These regulations require workers and employers to consider all overhead power lines to be energized until (1) the owner of the lines or the electric utility indicates that they are not energized, and (2) they have been visibly grounded [29 CFR 1910.333 (c)(3); 29 CFR 1926.550(a)(15)].
- Employers shall ensure that overhead power lines are de-energized or separated from the crane and its load by implementing

one or more of the following [29 CFR 1910.333(c)(3); 29 CFR 1926.550(a)(15)]:

- De-energize and visibly ground electrical distribution and transmission lines at the point of work
- Use insulated barriers that are not a part of the crane to prevent contact with the lines
- If the power lines are not de-energized, operate cranes in the area ONLY if a safe minimum clearance[†] is maintained as follows:

At least 10 feet for lines rated 50 kilovolts or below

At least 10 feet plus 0.4 inch for each kilovolt above 50 kilovolts; or maintain twice the length of the line insulator (but never less than 10 feet)

- Where it is difficult for the crane operator to maintain safe clearance by visual means, designate a person to observe the clearance and to give immediate warning when the crane approaches the limits of safe clearance [29 CFR 1926.550(a)(15)(iv)].
- Do not use cage-type boom guards, insulating links, or proximity warning devices as a substitute for de-energizing and grounding lines or maintaining safe clearance [29 CFR 1926.550(a)(15)(v)].

Follow ANSI Guidelines

Train workers to follow ANSI guidelines for operating cranes near overhead power lines (ANSI Standard B30.5–1994, 5–3.4.5)

[†]Clearance is the distance between the power lines and any part of the crane or its load.

[ANSI 1994]. These guidelines recommend posting signs at the operator's station and on the outside of the crane warning that electrocution may occur if workers do not maintain safe minimum clearance that equals or exceeds OSHA requirements as follows:

<i>Power line voltage phase to phase (kV)</i>	<i>Minimum safe clearance (feet)</i>
50 or below	10
Above 50 to 200	15
Above 200 to 350	20
Above 350 to 500	25
Above 500 to 750	35
Above 750 to 1,000	45

Notify Power Line Owners

Before beginning operations near electrical lines, notify the owners of the lines or their authorized representatives and provide them with all pertinent information: type of equipment (including length of boom) and date, time, and type of work involved. Request the cooperation of the owner to de-energize and ground the lines or to help provide insulated barriers. NIOSH encourages employers to consider de-energization (where possible) as the primary means of preventing injury from contact between cranes and power lines.

Develop Safety Programs

Develop and implement written safety programs to help workers recognize and control the hazards of crane contact with overhead power lines.

Evaluate Jobsites

Evaluate jobsites before beginning work to determine the safest areas for material

storage, the best placement for machinery during operations, and the size and type of machinery to be used.

Know the location and voltage of all overhead power lines at the jobsite before operating or working with any crane.

Research has shown that it is difficult to judge accurately the distance to an overhead object such as a power line [Middendorf 1978]. Therefore, NIOSH recommends that no other duties or responsibilities be assigned when workers are designated to observe clearance during crane movement or operation.

Evaluate Alternative Work Methods

Evaluate alternative work methods that do not require the use of cranes. For example, it may be possible to use concrete pumping trucks instead of crane-suspended buckets for placing concrete near overhead power lines. Alternative methods should be carefully evaluated to ensure that they do not introduce new hazards into the workplace.

Train Workers

Ensure that workers assigned to operate cranes and other boomed vehicles are specifically trained in safe operating procedures. Also ensure that workers are trained (1) to understand the limitations of such devices as boom guards, insulated lines, ground rods, nonconductive links, and proximity warning devices, and (2) to recognize that these devices are not substitutes for de-energizing and grounding lines or maintaining safe clearance. Workers should also be trained to recognize the hazards and use proper techniques when rescuing coworkers or recovering equipment in contact with

electrical energy. CSA guidelines list techniques that can be used when equipment contacts energized power lines [CSA 1982] (see Current Standards in this Alert).

All employers and workers should be trained in cardiopulmonary resuscitation (CPR).

Call for Help

Ensure that workers are provided with a quick means of summoning assistance when an emergency occurs.

Develop Safer Equipment

Encourage the manufacturers of cranes and other boomed vehicles to consider developing truck-mounted cranes with electrically isolated crane control systems, such as those that use fiber optic conductors to transmit control signals.

ACKNOWLEDGMENTS

The principal contributor to this Alert is Paul H. Moore, Division of Safety Research. Please direct any comments, questions, or requests for additional information to the following:

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1-800-35-NIOSH (1-800-356-4674).

We greatly appreciate your assistance in protecting the health of U.S. workers.



Linda Rosenstock, M.D., M.P.H.
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control
and Prevention

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Preventing Electrocutions of Crane Operators and Crew Members Working Near Overhead Power Lines

WARNING!

Crane operators and crew members may be electrocuted when they work near overhead power lines.

Take the following steps to protect yourself from electrocution when operating or working around cranes that are near overhead power lines:

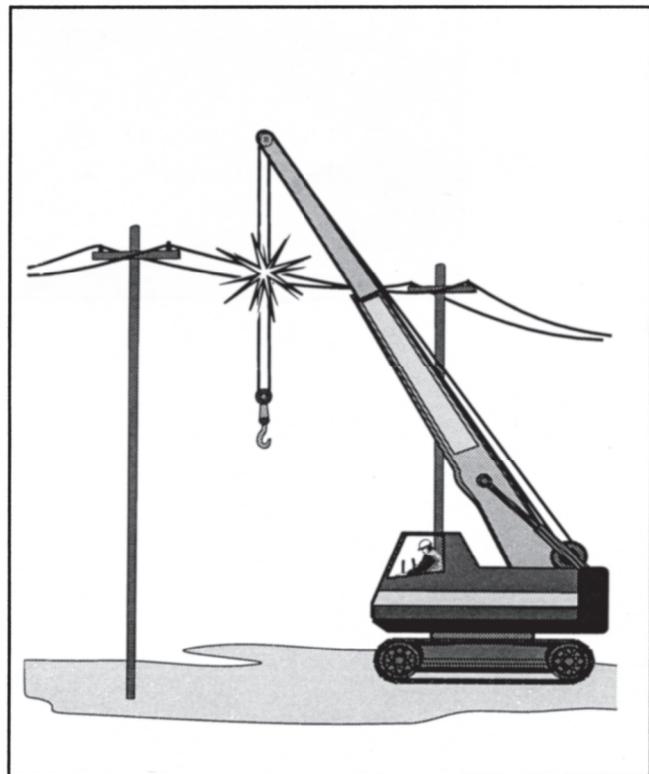
1. Operate cranes only if you have been trained in safe operating procedures and the Occupational Safety and Health Administration (OSHA) safety requirements.
2. Participate in all crane safety programs offered by your employer or labor organization.
3. Know the location and voltage of all overhead power lines at the jobsite before operating or working with any crane.
4. Assume that all power lines are energized and maintain the minimum clearance required by OSHA at all times:
 - At least 10 feet for lines rated 50 kilovolts or below
 - At least 10 feet plus 0.4 inch for each kilovolt above 50 kilovolts (or maintain twice the length of the line insulator, but never less than 10 feet)
5. For more protection, maintain the greater clearances recommended by the American National Standards Institute (ANSI):

Power line voltage phase to phase (kV)	Minimum safe clearance (feet)
50 or below	10
Above 50 to 200	15
Above 200 to 350	20
Above 350 to 500	25
Above 500 to 750	35
Above 750 to 1,000	45

6. Where it is difficult for the crane operator to see the power lines or pay attention to maintaining required

clearance during crane movement or operation, designate a person whose sole responsibility is to observe the clearance and to give immediate warning when the crane approaches the limits of safe clearance.

7. Be aware of the limitations of boom guards, insulated lines, ground rods, nonconductive links, and proximity warning devices. Do not use these devices as a substitute for de-energizing and grounding lines or maintaining safe clearance.



Workers are killed each year when cranes contact overhead power lines.

Call 1-800-35-NIOSH (1-800-356-4674) for additional information or for free single copies of the complete *NIOSH Alert: Request for Assistance in Preventing Electrocutions of Crane Operators and Crew Members Working Near Overhead Power Lines* [DHHS (NIOSH) Publication No. 95-108].

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