Crane Safety

Preventing Electrocutions From Contact With Overhead Power Lines

Case 1: A 28-year-old construction worker was holding onto a steel ladder being moved by a telescoping boom crane. As the crane’s boom was swung in the direction of 7,200-volt power lines, the cable made contact with the lines and the worker was electrocuted.

Case 2: A coowner of a steel erection company and three workers at the construction site of a commercial storage shed were using a telescoping boom crane to move a section of a steel-framing member. As the section was moved, it came in direct contact with a 23,000-volt overhead power line. Two of the three workers who were in direct contact with the load were electrocuted while the third received serious electrical burns.

Case 3: A construction company was in the process of laying concrete water pipe with a crane. As workers placed support timbers beneath the crane’s outrigger pads, the operator began extending the crane boom for the next lift when the boom came into contact with a three-phase 13,800-volt overhead power line. One worker touching an outrigger of the crane was electrocuted.

As these case studies illustrate, contact with energized power lines may result in one or more fatal electrocutions, serious burns and/or damaged equipment. The most common cause of crane-related fatalities is contact with overhead power lines. Electrocutions account for 32% of crane-related fatalities. Half of these electrocutions were associated with the crane boom or cable contacting an overhead power line, while others involved a power line coming into contact with unspecified parts of the crane (McCann, Gittleman, & Watters, 2008).

Based on CPWR’s review of crane-related fatalities that occurred from 1992 to 2006, the activities performed by construction workers when electrocuted by overhead power lines fall into one of several categories.

Assess the Hazard

Prior to beginning operations, a hazard assessment inside the work zone must be performed. The hazard assessment must:

1) Identify the work zone and assess it for power lines. Determine how close the crane could get to them. This assessment can be done for the area 360° around the crane or for a more limited, demarcated area.

2) If the assessment shows that the crane could get closer than a trigger distance—20 ft for lines rated up to 350 kilovolts (kV) (50 ft for lines rated over 350 kV)—then additional action is required.

Eliminate the Hazard

If operations involving cranes (or other high-reaching equipment) will be performed near overhead power lines and the minimum clearance distances, as specified by OSHA, cannot be maintained, the first option is to de-energize and visibly ground the power line(s). By eliminating the source, the electrocution hazard is eliminated. This must be coordinated with the utility company or line owner. The line owner may need several weeks to comply with the request, so work should be planned appropriately. Only authorized personnel may de-energize a power line. All power lines shall be presumed energized unless the utility owner/operator confirms that the lines have been and continue to be de-energized and visibly grounded at the site.

If the power line cannot be de-energized for the duration of work, another option is to move the line so that its minimum clearance distance can be maintained. Like de-energizing the line, only the company that owns the line may move it. Again, the line owner may take several weeks to comply with the request.

Figure 1 Activity of Construction Workers Electrocuted by Overhead Power Lines, 1992-2006

<table>
<thead>
<tr>
<th>Activity</th>
<th>1992-2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker on foot touching/guiding load or cables</td>
<td>40 39%</td>
</tr>
<tr>
<td>Operating crane*</td>
<td>32 31%</td>
</tr>
<tr>
<td>Worker on foot touching crane</td>
<td>19 19%</td>
</tr>
<tr>
<td>Other**</td>
<td>11 11%</td>
</tr>
<tr>
<td>Total</td>
<td>102 100%</td>
</tr>
</tbody>
</table>

* Includes seven deaths of operators who jumped from crane.
** Includes six deaths of workers on foot near crane

KEEN YOUR DISTANCE

OSHA’s requirements regarding working near overhead power lines with cranes and other high-reaching equipment are straightforward. The operator must keep all parts of the crane or other high-reaching equipment at least 10 ft away from all power lines 50 kV or less. For lifting equipment, this also includes any load being carried. This minimum clearance distance is a buffer zone that must be kept between the equipment and overhead lines. In other words, the minimum clearance distance is the minimum distance that is allowed between any part of a crane or other high-reaching equipment and an overhead power line.

If the lines are greater than 50 kV, then the line’s minimum clearance distance must be increased according to Table A of 29 CFR 1926.1408, Power Line Safety (Up to 350 kV)—Equipment Operations. Distribution lines, the most common lines used by utilities, are typically 50 kV or less, whereas transmission lines are typically greater than 50 kV. To determine the voltage rating of a power line, contact the utility company. If you still cannot determine the voltage range, then stay at least 45 ft away.

PREVENTING ENCOACHMENT OR ELECTROCUTION

If any part of the equipment, load line or load (including rigging and lifting accessories) could get closer than the minimum approach distance of the power line permitted in Table A (1926.1408), while operating up to the equipment’s maximum working radius in the work zone, the following precautions shall be followed:

1) Conduct a planning meeting with the operator and other workers who will be in the area of the equipment or load to review the location of the power line(s) and the steps that will be implemented to prevent encroachment/electrocution.

2) If tag lines are used, they must be nonconductive. Tag lines are ropes (usually fiber) attached to a lifting load for the purpose of controlling or are used to stabilize a bucket or magnet during material handling operations. Thus, one end of the tag line is attached to the load and the other end is held by an employee who controls the load’s motion by exerting force on the line. If the equipment or load were to make electrical contact with a power line while an employee was holding a tag line that conducts electricity, the employee could be electrocuted. The requirement that the tag line be nonconductive is designed to protect against such an event. Nonconductive objects have properties that do not allow them to become energized, such as high dielectric properties offering high resistance to the passage of current. In practice, under dry conditions, nonmetallic fiber rope typically satisfies the definition of nonconductive.

3) Erect and maintain an elevated warning line, barricade or line of signs in view of the operator, equipped with flags or similar high-visibility markings, at 20 ft from the power line or at the minimum approach distance under Table A. Preferred barricading methods include erecting temporary fencing and placing equipment or storage containers at the minimum distance barrier line to prevent equipment movement within the encroachment zone. However, such boundaries must still be marked with flags, a warning line and/or signs that limit all crane movement. If the operator is unable to see the elevated warning line, a dedicated spotter must be used.

In addition, at least one of the following measures must be implemented: proximity alarm, dedicated spotter, range control device, range of motion limiting device and/or insulating link.

PROXIMITY ALARM

Proximity warning devices are designed to warn the crane operator when s/he moves any part of the boom too close to an overhead line. The device must be listed, labeled or accepted by a nationally recognized testing laboratory. The device should be set to give the operator sufficient warning to prevent encroachment.

It is possible to get false readings with these devices. In a study published in 2009, NIOSH tested the efficacy of two proximity alarm models under various simulated construction conditions. The study showed that the device accuracy could be adversely affected by factors, such as:
1) operating the equipment with a boom angle and length significantly different than that used for the device’s last sensitivity adjustment;
2) operating the equipment on sites with multiple overhead power lines, especially where those power lines have differing voltages or involved intersecting installations (Homce, Cawley & Yenchek, 2008). Due to these limitations, the preamble to OSHA’s Cranes and Derricks in Construction Final Rule (2010) indicates that no proximity alarm can be listed, labeled or accepted by a nationally recognized testing laboratory until the problems identified by the NIOSH study have been rectified.

**Dedicated Spotter**

A dedicated spotter has the sole responsibility to watch the separation between the power line and the equipment, the load line and load and to ensure through communication with the operator that the applicable minimum distance is not breached. The dedicated spotter must be a qualified signal person.

However, situations in which the equipment operator needs the assistance of a signal person to provide signals related to maneuvering the equipment or load other than maintaining the required power line clearance distance require a different person to serve as the signal person. The dedicated spotter must be positioned so that s/he can effectively gauge the clearance distance from the power line; the spotter, where necessary, must use equipment that enables him/her to communicate directly with the equipment operator; and the spotter must give timely information to the operator so that the required clearance distance can be maintained.

**Range Control Warning Device**

A range control warning device automatically warns the operator when to stop movement. This type of device can be set by an equipment operator to warn that the boom or jib tip is at a plane or multiple planes. For example, if an employer has chosen the option of that the boom or jib tip is at a plane or multiple planes.

The dedicated spotter must be positioned so that s/he can effectively gauge the clearance distance from the power line; the spotter, where necessary, must use equipment that enables him/her to communicate directly with the equipment operator; and the spotter must give timely information to the operator so that the required clearance distance can be maintained.

**Range of Motion Limiting Device**

A range of motion limiting device automatically limits the range of movement, preventing encroachment. Such a device can be particularly suitable for tower cranes, for which the swing angle can be programmed so that the operator cannot move the boom or jib past a certain range. While it may be more technically difficult to apply swing limitation devices for use with mobile cranes, technology may be developed allowing them to be used in such cranes.

**Insulating Links**

Insulating links do not protect against encroachment but provide protection to employees handling the load against electrocution in the event that encroachment occurs. When using insulating links, they should be installed at a point between the end of the load line (or below) and the load. If power line contact occurs, the linkage will prevent electricity from passing to the load.

The entire structure of the crane, however, is not protected and will remain energized. Therefore, it is possible for the rigger to be protected, but any worker near the crane body may be electrocuted from the current passing through the ground. When insulator links are used, it is important to understand that the operator still should not allow any part of the crane or load to go within the power line’s minimum clearance distance. Also, insulating links must be listed, labeled or accepted by a nationally recognized testing laboratory.

**Additional Safety Measures**

Additional safety controls may be instituted to further prevent and/or protect against power line contacts. However, the measures previously discussed must still be implemented if any part of the equipment, load line or load (including rigging and lifting accessories) could get closer than the minimum approach distance of the power line permitted in Table A (1926.1408) while operating up to the equipment’s maximum working radius in the work zone.

**Insulated Sleeves**

Insulated sleeves can be attached directly to the power lines. The sleeves (made of nonconductive material) prevent physical contact between the crane and the power line. Only the utility company or the line owner’s representative may install insulated sleeves. These are designed only for brush contact; the minimum distance must still be maintained even if insulated sleeves have been installed.

**Boom-Cage Guard**

A boom-cage guard is a nonconductive cage that surrounds the boom of the crane. If power line contact occurs with a boom-cage guard, it will prevent the boom from becoming energized, thus protecting all work-
ers involved. The drawback of this technology is that it only protects the portion of the boom covered by the cage-guard. Contacts can still occur on other parts of the boom, the load line and the load. Again, the operator must still maintain the minimum clearance distance of the power line as specified in Table A.

**What to Do if You Hit a Line**

Power line contacts involving mobile cranes generally do not result in injuries to the crane operator. Riggers or other workers standing near the equipment often experience injuries and death. Fewer operators are injured because of equipment design. If contact occurs, the operator is at the same voltage potential as the equipment.

When the operator is isolated in the crane cab and contacts a line, the operator should wait in the crane, and all other workers should stay away from the equipment. The line should be de-energized by the power company before the operator leaves the crane cab or until contact between the boom and the power line is broken. Only under extreme circumstances (e.g., fire) should the operator leave the equipment.

If the operator must leave the equipment, the operator needs to jump from the equipment and land feet together. Care must be taken not to touch any part of the crane and the ground at the same time. The operator must then shuffle his/her feet in very small steps (or bunny hop) away from the crane. After a power line contact, the current flows outward from the point of contact through the soil in a ripple pattern. Areas of high and low potential encircle the energized equipment like ripples in a pond after a stone hits the surface. If a person steps from an area of high potential to an area of low potential, electricity can flow through the person’s legs, causing injury or death. Other workers in the area surrounding the energized equipment must also stay away because of the current flowing through the ground.

**The Bottom Line**

Contact with overhead power lines continues to be the most common cause of crane-related fatalities. Overhead power lines should be identified before any equipment arrives on site by conducting an assessment inside the work zone. If the assessment shows that the crane could get closer than a trigger distance (i.e., 20 ft for lines rated up to 350kV), then measures must be taken to prevent encroachment and electrocutions. The first consideration should be to de-energize and visibly ground the power lines. If this is not feasible, other safety precautions must be taken to ensure the minimum clearance distance for the power line(s) is maintained. For power lines less than 50 kV, the boom and all parts of high-reaching equipment must be kept at least 10 ft away. For power lines with greater voltages, the minimum clearance distance is increased. Additional safety measures can be taken to prevent contact with overhead power lines. However, the bottom line is to keep your distance.

**References**


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