

Fall Protection and Cranes: How to Provide Fall Protection in Industrial Crane Environments

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Introduction

Providing fall protection in crane environments is one of the more difficult issues safety professionals face in general industry. Crane environments can be busy, noisy, cluttered, and dangerous places. When fall protection is provided for workers maintaining a crane, or when fall protection is provided for workers underneath the crane, the environment can become even more hazardous. Compounding the difficulty, OSHA rules are either vague or not defined for these types of fall protection usage around cranes.

The most common requirement for fall protection around cranes is when fall protection must be supplied to workers who are guiding a load onto a flat bed truck while a crane is positioning the load. The overhead crane and overhead fall protection must work in the same space. The interplay between the crane and fall protection equipment can become problematic, as the crane may be able to easily contact the fall protection equipment and vice versa. Historically, crane operations have been defined in OSHA 1910 for operating cranes around workers on ground level. Unfortunately, there is little information on how to effectively operate industrial cranes around workers who are also wearing fall protection that is tied off to an overhead attachment. When fall protection systems are incorporated into these crane working environments there can be many new issues such as crane contact, impact, entanglement, and dragging that need to be addressed.

This paper will review the current best practices in general industry and other industries, review examples of how workers are kept safe while using fall protection around cranes in general industry, and review examples of how fall protection anchorages can be provided in industrial crane environments. The ANSI Z359.2 Fall Protection Code will be used as a guide for managing these fall protection programs, and OSHA law will be stated for general industry and referenced for other industries. Where OSHA law does not exist for general industry, OSHA's web site states: "Where OSHA has not promulgated specific standards, employers are responsible for following the Act's general duty clause. The general duty clause of the Act states that each employer "shall furnish a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees"." OSHA laws from other industries will be provided as reference for ideas on how to potentially provide a "place of employment which is free from recognized hazards."

The organization of this paper is in two sections. The first section of this paper will cover the protection of workers working on, above, or adjacent to overhead electric cranes, and the second sections of the paper will cover providing fall protection for workers who work directly under overhead cranes.

Applying Hazard Hierarchies to Fall Hazards and Equipment Hazards

Two hierarchies of hazard analysis exist that cover our application of fall protection around cranes. They are ANSI's "Fall Hazard Hierarchy" and OSHA's "Hierarchy of Controls."

The ANSI Z359 Fall Protection Code defines the methodology for eliminating and controlling fall hazards in Specification Z359.2 "Minimum Requirements for a Comprehensive Managed Fall Protection Program." This "Fall Hazard Hierarchy" is employed in situations where workers must interact with fall protection equipment.

The ANSI Fall Hazard Hierarchy provides safety to the worker from the dangers of a fall hazard by employing various levels of fall protection equipment or controls:

1. Elimination or Substitution
2. Passive Fall Protection
3. Active Fall Restraint
4. Active Fall Arrest
5. Administrative Controls

OSHA's Hierarchy of Controls must be followed when a worker interacts with powered equipment that poses a danger or threat to the person's safety. The OSHA Hierarchy of Controls provides safety to the worker from the dangers of powered equipment by employing various levels of equipment design or controls:

1. Eliminate the situation
2. Employ engineering controls.
3. Administrative Controls
4. Personal protection equipment

Section 1a- Fall protection planning for crane maintenance

Crane maintenance and annual inspections require workers to work on, above, and adjacent to facility cranes. Unfortunately, access areas to these cranes are generally narrow, dirty, and cramped, with few places to walk or stand. As a result these work areas are extremely dangerous to crane maintenance workers. The crane industry, regrettably, has had many fatalities over the years because of insufficient fall protection for workers who must access this equipment.

Fall protection plans should be developed that not only provide fall protection, but also employ other controls to protect workers from external sources of injury hazards. For example, if maintenance must take place on a bridge crane while other bridge cranes are still continuing to travel along the same shared runway, then administrative controls must be employed to prevent impact and workplace intrusion issues.

The administrative controls employed to protect workers against falls and injuries during annual crane inspections, routine maintenance, or major repairs should be defined in a fall protection plan. The plan should be written down on paper with sufficient detail for a novice to execute the proper steps:

1. Have a written checklist to ensure all proper steps are taken before any work begins.
2. Crane operators' meeting- Have a meeting in the morning to notify all crane operators, workers and supervisory personnel of the day's work schedule. Operators of cranes who are working on the same runway as the crane being maintained must be aware of their limited travel lengths. Crane operators must be aware that impacts with "down" cranes or personnel lifts can result in injuries or fatalities.
3. Post work schedule- The work schedule should be easily visible for all affected workers so workers will not be surprised when they see an area of the floor roped off.
4. Rope off the area- The floor area directly below the crane should be roped off with highly visible security tape or personnel barriers. This prevents entry of workers into the area where errant parts and tools can fall, and also acts as a visual reminder to other crane operators that the area directly above the rope barrier has an inoperable crane with workers on the above crane structure.
5. Hang a 4 ft x 6 ft fluorescent flag from the runway to notify other crane operators of the crane in service.
6. Perform a lock-out and tag-out on the runway and bridge crane being inspected or maintained. If maintenance will occur on the bridge only and the remainder of the runway needs to remain electrified, lock-out and tag-out only the bridge and section of runway under repair. Extreme caution should be used around live power conductors.
7. Use temporary runway rail stop clamps- Runway rail stop clamps will help prevent the intrusion of a powered crane into the working area of a crane undergoing repair or inspection. Runway stops will not a guarantee that a powered crane will stop. Stops should be placed at least 15 feet from any personnel lift or crane under maintenance.
8. In lieu of rail stops, temporarily disabled "buffer" cranes can be positioned between live cranes and the crane being maintained.
9. Work with a "buddy". The second worker's job is to remain aware of the surroundings and potential dangers while the primary worker focuses on the repair or inspection at hand. Furthermore, the second worker can assist in the event of an injury or call for help should a serious injury occur or should a fall occur that requires rescue assistance.
10. Employ fall protection as defined in Section 1b.

Section 1b- Fall Protection systems for crane maintenance

Annual inspections on cranes require an inspector to have full visual access to every section of runway and bridge travel to make sure all structural supports and runways are sound and free of damage, breaks or stress cracks.

The typical way of performing these inspections is to physically walk along the runways and walk along the bridge rails. Usually the geometry of the work areas, especially runways, will not lend itself to guardrails or other forms of passive restraint. Inspection companies have recently begun to migrate towards working strictly from the safety of a boom lift. Boom lifts and scissor lifts have guardrails around the basket or work platform as passive fall protection. If boom lift access is not available and the crane's geometry precludes passive systems, the next choice is some form of active fall protection like fall restraint or fall arrest.

Fall arrest can be provided along runways and along bridges. Some hoist trolleys such as double girder hoist trolleys tend to be problematic due to the bulky and awkward shapes. Single point attachments can work well on hoists if a boom lift can safely provide access to the attachment points.

The most common usage of fall protection for these areas is as follows:

- Fall protection along a runway
 - Wire rope
 - Rigid Track
- Fall protection along a bridge
 - Guardrail/walkways
 - Wire rope
 - Rigid Track
- Fall protection at Hoist
 - Boom lift
 - Fall restraint
 - Single point attachment

Personnel lifts such as boom lifts and scissors lifts are the preferred method to access hard to reach areas due to the passive nature of the platform hand rails, ease of access to inspection sites, and the width and stability of the platform.

Section 2a- Fall Protection for Workers underneath an Overhead Crane

There are many different configurations available to provide fall protection underneath industrial overhead cranes. Foldaway monorails, rotating swing arms, wall travelling jib arms, and fixed monorails can be positioned below overhead cranes. Alternatively, ceiling mounted monorails or travelling bridges can be positioned above the overhead cranes.

As the crane and the overhead fall protection must occupy the same space, there are potential issues:

- A. Structural Impact- If a structure that provides fall protection is located below the crane, the crane can impact the structure. These impacts can cause material damage issues to the structure or potential catastrophic failure of the structure, endangering workers below.
- B. Fall Arrest Lanyard “Pushing”/”Dragging”- If the structure that supports the fall protection equipment is positioned above the crane, there is risk that the crane operator will drive the crane into the fall arrest lanyards and drag the workers away. This is probably the highest-risk issue as the crane operator is almost always focused on the load which is close to floor level, and not focused on the crane structure’s movements overhead.
- C. Entanglement- Entanglement of the crane’s cables with a fall protection worker’s lanyard can only occur if the fall protection worker’s movements relative to the hanging load block’s movements results in a circular “wrapping” motion.

Structural Impact effects (Issue “A”) can be mitigated with Engineered Control solutions such as trip wires, safety stop sensors, or light curtains on the fall protection structures that would immediately remove power from the crane should an impact occur with fall protection equipment.

Sensors mounted on the extremities of the fall arrest structure and could enable the following:

- Shut off motion in the direction of crane travel
- Power would be automatically locked out, and only resettable by a manager
- The crane operator or supervisor would file a “near miss” report to define the lessons learned and future corrective actions
- The crane operator could be required to complete a refresher crane operator training course

Additionally, design features could be incorporated into the system that would help prevent the impact from occurring:

- Structure should be painted a highly visible color like safety yellow.
- Foldaway structures or temporary structures should incorporate flashing lights or strobe effect lights that can grab the attention of a crane operator and focus it on the structure’s relative position to the crane and lifted load. The lights should be bright enough to cut through the clutter of a busy industrial factory floor. Lights should be a minimum of 2500 candlepower (or candelas) to be seen in most all industrial environments.
- Software control limits for any computer controlled crane motions

Issue “B”, where a crane can “Push” the fall arrest lanyards is a little more complicated. If we look at the OSHA’s hierarchy of controls for general machinery and equipment, we must first try to #1, eliminate the situation, or #2, employ engineering controls. The engineering controls would be similar to the “impact” issue solutions- trip wires, safety stop sensors, or light curtains mounted on the crane structure to immediately remove power from the crane should an impact occur with fall protection equipment. If we cannot use engineering controls, the next level on OSHA’s hierarchy is “Administrative Controls”.

Administrative controls can be tailored to be very effective in preventing pushing or dragging. As the operator is the key to making the operation as safe as possible, the administrative controls will focus around this key figure.

A typical plan could include:

- The crane operator must be trained to know all protocols of the lifting and fall protection plan. OSHA lifting protocols are defined for General Industry in 1910.179(n).
- The lifting and fall protection plan must be written down.
- The lifting and fall protection plan must be site specific.
- The workers using fall protection must be trained to know all protocols of the lifting and fall protection plan.
- The crane operator must be able to see all workers at all times. Zones can be designated on the ground or on the work platform where workers must stand so that the crane operator can see them. For reference, OSHA defines this in construction law in 1926.1425(b) through (c) and (e)(2).
- The crane operator must be able to communicate with all workers at all times.
 - Background noises must be kept to a minimum so voices can be heard. For reference, OSHA defines this in construction law in 1926.1421.
 - Radio controls must be employed to insure 100% communication if voice commands cannot be heard due to background noise or distance. For reference, OSHA defines this in construction law in 1926.1420.
 - A signaler may be required if the point of operation is not in full view of the operator. For reference, OSHA defines this in construction law in 1926.1419.
 - Language must not be a deterrent to communication. All workers must be able to fluently speak and understand and communicate in a chosen language.
 - A “lead” man must be designated to direct the lift. This is the fall protection worker who is always closest to the crane and closest to the lifted load.
 - The lead man is normally the primary person who communicates with the crane operator.
- If the crane is to be operated from a control pendant at the worker’s level, the best possible solution is to have the “lead” worker also be the crane operator. The logic is, the operator will be the least likely to drive the crane structure into his own fall protection equipment. And as long as the other workers using fall protection are farther away from the crane and the load than the “lead,” all other workers are theoretically protected from being pushed or dragged.

Entanglement issues (Issue “C”) such as entanglement of the cranes cables with a fall protection worker’s lanyard occur if the fall protection worker’s movements relative to the hanging load block’s movement results in a circular “wrapping” motion.

Administrative controls can also be tailored to be very effective in this situation to prevent entanglement. As the fall protection user is the key to eliminating this potential the administrative controls will focus around this key figure:

1. The plan must be written down for all to follow.
2. The workers using fall protection must be trained to know all protocols.
3. Crane speeds must be as slow as possible.
4. Communication to the crane operator must be 100% unbroken.
5. All coworkers must be vigilant to the position of the crane’s lifting line relative to their own fall protection lanyard and their coworker’s lanyards. Workers must notify anyone who may be in a position for potential entanglement.

6. Lifts should stop immediately if a potential entanglement situation exists.

Section 2b- Fall Protection for Workers from Overhead Cranes

Is tying off directly to a non-moving crane or headache ball (or a below the hook attachment) allowable per OSHA? Yes, but as of right now, it's only defined for construction applications.

For reference, OSHA has just recently clearly defined simple usage in the release of 1926 Subpart CC Cranes and Derricks in Construction. This law became effective on November 8th, 2010:

- 1926.1423(j) *Anchoring to the load line*. A personal fall arrest system is permitted to be anchored to the crane/derrick's hook (or other part of the load line) where all of the following requirements are met:
- 1926.1423(j)(1) A qualified person has determined that the set-up and rated capacity of the crane/ derrick (including the hook, load line and rigging) meets or exceeds the requirements in 1926.502(d)(15).
- 1926.1423(j)(2) The equipment operator must be at the worksite and informed that the equipment is being used for this purpose.
- 1926.1423(j)(3) No load is suspended from the load line when the personal fall arrest system is anchored to the crane/derrick's hook (or other part of the load line).

Also, OSHA does not define how many people can be tied off to the approved hook at one time. One can infer from the wording that it is only one; however some companies limit the maximum amount of people to two. The safety professional must use judgment to determine which would work safest for their application.

For General Industry, OSHA may allow direct attachment to a crane but only if OSHA's Hierarchy of Controls are followed. In other words, the crane attachment point, crane controls, and administrative controls must be engineered or validated by a Qualified Person. Besides using the crane's hook as an anchorage point, engineers have successfully added rigid track anchorage systems along crane bridges to provide fall protection coverage to linear work areas. The Administrative Controls would require the crane to be locked out and tagged out before using the crane's structure as a fall arrest anchorage point. Employers should consult with their local state-run OSHA program or, if applicable, the federal OSHA for more information on their specific plan to protect workers from falls.

So what does OSHA feel about attaching to a live moving crane? OSHA does allow for attachment to a live active crane in motion but only in two very specific applications. Again neither application is for general industry, but this information could be used for ideas on how to comply with OSHA's requirement to provide a "place of employment which is free from recognized hazards":

1. For Construction activities, fall protection may be attached to the headache ball or load block for use by a worker on a boatswain's chair being lowered or retrieved from a shaft or storage tank. Reference OSHA1926.1431(s)(3)(iii).
2. For Longshoring activities, OSHA 1918 allows a worker to attach to a live moving crane for Longshoring containerized cargo operations:
 - 1918.85(k)(7) When "live" (activated) container gantry crane lifting beams or attached devices are used as anchorage points, the following requirements apply:
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 - 1918.85(k)(7)(i) The crane shall be placed into a "slow" speed mode;
 - 1918.85(k)(7)(ii) The crane shall be equipped with a remote shut-off switch that can stop trolley, gantry, and hoist functions and that is in the control of the employee(s) attached to the beam; and
 - 1918.85(k)(7)(iii) A visible or audible indicator shall be present to alert the exposed employee(s) when the remote shut-off is operational.
 - 1918.85(k)(12) Before using any fall protection system, the employee shall be trained in the use and application limits of the equipment, proper hookup, anchoring and tie-off techniques, methods of use, and proper methods of equipment inspection and storage.
 - 1918.85(k)(13) The employer shall establish and implement a procedure to retrieve personnel safely in case of a fall.

In summary, OSHA does allow for tying off to cranes but only for specific applications and specific industries. As OSHA has not defined specific standards for General Industry, employers are responsible for following the Act's general duty clause. OSHA's general duty clause states that each employer "shall furnish...a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

Employers should consult with their local state run OSHA program or, if applicable, the federal OSHA for more information on their specific plan to protect workers from falls.

Conclusion

A safety professional must review each individual installation of fall protection equipment for interactions with any other equipment, such as cranes, that may be operated within or move into the working envelope of the fall protection equipment. Proper safeguards, functional controls, interlocks, and/or administrative controls must be provided and employed to prevent interaction between equipment that may jeopardize the safety of the workers using fall protection.

Analysis must include, but is not limited to, the applicable fall protection user program requirements and hazard hierarchies defined within ANSI Z359.2 and OSHA 1910.

Bibliography

1. ANSI/ASSE Z359 Fall Protection Code, American Society of Safety Engineers.
2. Occupation Safety and Health Act (OSHA) 29 CFR, U.S. Department of Labor.