Crane Operator Dies after Falling From Crane Turntable Deck in Washington State

FACE/WA
Fatality Assessment and Control Evaluation

Investigation: # 10WA046
Release Date: October 11, 2011
SHARP Report: # 52-22-2011

Washington State Department of Labor & Industries

SHARP
Safety & Health Assessment & Research for Prevention

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SUMMARY

In July of 2010, a 61-year-old male crane operator was fatally injured when he fell from a mobile hydraulic crane's turntable deck while attempting to dismount from the crane. Two employees of a construction crane service company were dispatched by their employer to an elementary school where they were to lift an HVAC unit to the top of a school building. The crane operator (victim) and oiler set up the 120-ton mobile hydraulic crane in preparation for the lift when they discovered that there was an electrical problem causing the telescoping boom to not function. The operator made telephone contact with the company electrician who indicated that he would be there shortly to make repairs.

The two workers decided to go and wait in the shade. The victim's coworker dismounted from the turntable deck at the rear of the crane and turned away from the victim who was also about to dismount. The coworker then heard the victim make an exclamation and he turned to see him falling head first to the concrete sidewalk 4 to 5 feet below. A call was made by another contractor to emergency medical services (EMS). EMS and police responded and the victim was transported to a hospital. He died of his injuries nine days later.

RECOMMENDATIONS

To prevent similar occurrences in the future, the Washington State Fatality Assessment and Control Evaluation (FACE) investigation team recommends that employers who use cranes and other mobile equipment should follow these guidelines:

- **Identify and address fall hazards associated with workers mounting and dismounting from cranes and other mobile equipment.**
- **Ensure that cranes and other mobile equipment have safe, well designed access systems.**
- **Maintain mobile equipment access systems and walking and working surfaces in a safe and useable condition.**
- **Consider the safety needs of older workers.**

Crane and mobile equipment designers and manufacturers should:

- **Consider designing safer access systems for mobile equipment.**

Safety researchers should:

- I**nvestigate the human factors issues involved in mobile equipment access systems.**

INTRODUCTION

In July of 2010, the Washington State FACE Program was notified by the Division of Occupational Safety and Health (DOSH) of the death of a 61-year-old male crane operator who had fallen from the turntable deck of a mobile crane. In April of 2011, Washington State FACE investigators traveled to the company's office and met with and interviewed a part owner and the person in charge of overseeing company safety, safety training, and electrical maintenance of cranes. Photographs were taken of the incident crane which was then at the company yard. During the course of the investigation documents reviewed included the victim's death certificate, coroner's report, and DOSH investigation documents and photographs.

Employer

The employer is a construction crane service that has been in business since 1975. The owners of the company also have a general contracting business that shares 35 fulltime employees between the two businesses. There are eight other company employees that are crane operators. At the incident site there were two employees, the crane operator (victim) and an oiler. It is a non-union company.

Employer Safety Program and Training

The employer has a comprehensive written health and safety program. All Washington State employers are required to have a formal written accident prevention program (APP) which is tailored to the specific needs of their workplace and the types of hazards likely to be encountered. However, this employer's APP did not specifically address fall hazards associated with employees getting on and off of cranes or accesses to the crane and its parts to perform various tasks.

The company has a designated person in charge of health and safety who also is a crane operator and electrician. This individual estimates that he spends between 30 – 40% of his job on safety related activities. The employer holds crew safety meetings once a month. Safety meetings are also held when issues need to be discussed. New employees who are hired as crane operators are required by the employer to show that they are safely able to operate a crane. This involves demonstrating their skills by performing various maneuvers and tasks with a crane at the company yard.

Crane operators are hired based on their experience and ability to operate a crane. The company sends their crane operators to a three day training class, but most of the training is done on the job. Before going out on a job the crane operator will discuss with the company safety officer what he is going to do and any issues involved in the lift.

In Washington State as of January 1, 2010, construction crane operators are mandated by a state law enforced by the Washington State Department of Labor and Industries' Division of Occupational Safety and Health (DOSH) to meet qualification and certification requirements. (1) Under the provisions of the law, with exceptions for trainee/apprentice requirements, an employer must ensure that a crane operator has a valid crane operator certificate for the type of crane to be operated which is issued by a crane operating testing organization accredited by a nationally recognized accrediting agency. To achieve the certification the crane operator must pass a written and practical examination. Also, crane operators must have specified hours of experience for the type of crane operated and pass a substance abuse test conducted by a recognized laboratory. All of the company crane operators were certified.

Victim

The victim had worked for his employer for about 20 years, 11 of those years he was employed as a crane operator. He had previously worked as heavy equipment operator for this employer and as a log truck driver in the logging industry. He was a fulltime employee and one of the company's most experienced and skilled crane operators. He was a certified crane operator, as required by Washington State law and an accredited construction crane certifier. The victim had operated the incident crane many times.

Equipment

The crane involved in this incident was a 120-ton truck- or carrier- mounted hydraulic mobile crane with a telescoping boom (see photo 1). The crane's wheel-mounted truck carrier, designed for transporting the crane's superstructure which is mounted on it, is 40 feet 9 inches long by 10 feet 11 ½ inches wide. The top of the crane's turntable deck is 5 feet 1 ¼ inches high off the ground. The crane is designed to travel to and about a job site under its own power. It was manufactured in 1991 and was purchased used the employer. In addition to the original manufacturer's placement of ladders, steps, handrails, and handholds used to access parts of the crane and as aids to mounting and dismounting, the previous owner had added extra handholds and steps at various locations (see photos 3-5, 8, 9). The crane's walking surfaces were coated with an anti-slip coating. No modifications to the crane were made by the current owner. In Washington State all cranes used in construction must be certified that they meet certain requirements for safe operation, as specified by state law. The crane was a certified crane, as specified by state requirements. Comprehensive crane safety inspections are done yearly. Pre-job walk around safety inspections are performed by the crane operator before the crane leaves the company yard.

INVESTIGATION

In July of 2010, the victim, a 61-year-old crane operator, and another company employee, an oiler, were dispatched by their employer to an elementary school job site where their assigned task was to lift an HVAC unit to the top of the school's roof. The victim's employer was the sub-contractor hired by the heating and ventilation company installing the HVAC unit. Before leaving the company yard that morning the crane operator performed the required pre-job walk around crane inspection. The victim and oiler arrived at the job site at approximately 8:30 AM. The job was expected to take between an hour and an hour and a half. The school was a one-story building.

The victim and oiler discussed what they needed to do and where to best perform the pick of the HVAC unit. The victim was responsible for making decisions about the lift at this job site; this was the normal company procedure. If the operator determined that there were any problems he would contact his company office and, if necessary, talk with representatives of their general contractor on the job site. They determined where they wanted to make the lift and in preparation for the lift they backed the crane into the school parking lot (see photo 10). Following standard operating procedures they put down cribbing, leveled the crane, and put down its outriggers for stability. The ground beneath and around the crane was a flat and level parking lot. The back of the crane was next to the curb of a concrete sidewalk.

When they attempted to put the telescoping boom of the crane into hoisting mode, they found that it would not telescope all the way out. The crane operator called his company's office and was told to check the crane's electrical panel to see if there was a blown breaker. The operator and oiler then went to look at the crane's electrical panel, which was located in the crane's motor case to the rear of the crane cab and is accessed from the crane's turntable deck (see photos 1, 6, 7). The crane's cab housing was turned to about the 2 o'clock position. They checked the crane's control switch and decided that the problem was related to the electrical system. The crane operator then placed a call to the company's electrician and explained the problem. The electrician who was out on a job stated that he would be there to make the repair in about 45 minutes to an hour. It was about 9:30 AM and starting to get warm (perhaps 75 to 80 degrees, the daytime high was 100 degrees), so they both decided to get down from the crane and go wait in the shade.

The rear of the crane had a number of handholds and steps that were positioned to assist in mounting and dismounting from the deck. In addition to these the crane's previous owner added additional steps and handholds (see photos 1-5, 8, 9). The metal decking surface was covered with a non-slip material. This location was one that was often used by the victim to exit the crane and given the 2 o'clock angle of the crane cab housing it was the nearest way to climb down from the deck. The decking surface was

free of oil, water, and debris. The victim was wearing a hard hat, work gloves, and work boots with non-slip soles; he was not carrying anything in his hands or arms.

The oiler dismounted from the turntable deck right side of the crane and along with an employee of the company responsible for installing the HVAC unit, turned his back to the crane and began to walk away. The victim was on the rear of the crane turntable deck about to climb down the 4 to 5 feet from the deck to the sidewalk.

A few seconds later the oiler and the other employee from the heating and air conditioning company, who both had their backs turned to the victim, heard the victim make an exclamation and they turned to see him falling head first, face forward from the crane's turntable deck. The victim landed on his head 4 to 5 feet below on a concrete sidewalk. His hard hat came off as he fell. The heating and air conditioning contractor employee went in to the school to make a phone call to emergency medical services while the oiler applied pressure to the victim's bleeding head. EMS personnel were dispatched at 9:43 AM and arrived on the scene at 9:48. A police officer responded as well. The victim, who was unconscious, was given initial medical treatment at the scene by EMS responders and then transported by an ambulance to a hospital. He was then flown by helicopter to another hospital where nine days later he was taken off life support and died. Lab tests showed no indication of alcohol or drug use. The victim had no other known health conditions.

CAUSE OF DEATH

The medical examiner listed the cause of death as subdural hematoma, subarachnoid hemorrhage, multiple facial and skull fractures, and blunt force injury of the head.

RECOMMENDATIONS AND DISCUSSION

Recommendation #1: Employers should identify and address fall hazards associated with workers mounting and dismounting from cranes and other mobile equipment.

Discussion:

Falling is a hazard associated with mobile equipment mounting and dismounting and cab ingress and egress. (2-11) Construction equipment operators and others, such as riggers and maintenance personnel, frequently mount and dismount from parts of their assigned equipment, usually without injury. But injuries from falling while engaged in these activities do occur and may result in injuries such as an ankle, knee, or back

sprain; more serious injuries may include broken bones, dislocated shoulder, concussion, and sometimes, as in this case, a fatality. (2, 4, 12)

To prevent falls employers should identity conditions and procedures that put employees at risk and then create a company policy and train and supervise operators and other employees in safe procedures when mounting and dismounting from mobile equipment. This applies to access to and from the cab and to all other parts of the equipment where work is expected to be performed. The policy and training should include the following;

- Maintain 3-points of contact -- two hands and one foot, or one hand and two feet – with the equipment or ground at all times. This method allows for greater stability and control and reduces the possibility of a fall.
- Face toward the equipment, both when mounting and dismounting. This allows for better balance and use of handholds/handrails and better contact of the foot with steps.
- Do not jump. This increases the impact forces on the knees, ankles, and spine which may cause a sprain or over time conditions such as osteoarthritis of the knees. Also it increases the possibility of slipping and falling when landing on slippery or uneven surfaces.
- Mount and dismount equipment only where steps, ladders, and handrails/handholds are provided.
- Look before dismounting to be sure that there are no obstacles, such as holes, uneven ground, ice, or other conditions that may affect footing.
- Wear footwear with slip resistant soles.
- Clean mud off of footwear.
- Do not carry anything in hands, so as to be able to use handholds/handrails. Use a hand line and bag/bucket to raise or lower equipment.

Recommendation #2: Employers should ensure that cranes and other mobile equipment have safe, well designed access systems.

Discussion:

Mobile equipment access systems include such components as steps, ladders, handrails, handholds, platforms, and guardrails allowing workers to enter and exit the equipment cab and mount and dismount other parts of the equipment where work is expected to be performed. Many falls from mobile equipment and vehicles can be attributed to nonconformance to established design standards and guidelines. It is more effective to have well designed access systems or make design improvements

than to change human behavior. Equipment access systems should be designed for the ease and safety of the user. If these systems are absent or poorly designed, then there is an increased risk of falling to the user. (2-11, 13, 14, 15)

Some issues to consider about mobile equipment access systems:

- Ensure that your employees are able to easily reach steps, handrails, and handholds, both during entry and exit or mounting and dismounting.
- Ask employees for their input and suggestions when buying new equipment or retrofitting older equipment.
- Review company injury data to determine if employees are experiencing injuries related to their use of access systems or lack of adequate means of getting on and off equipment.
- When purchasing or retrofitting older equipment be sure that the access systems are designed with sound safety engineering principles.

The following are some principles that outline minimum criteria of safe access systems for mobile equipment as outlined in the Human Factors Design Handbook, the Society of Automotive Engineer's consensus standard SAE J185-2003 Access Systems for Off-Road Machines, and the International Organization for Standardization's consensus standard ISO 2867-2006 Earth-moving Machinery – Access Systems, and the American Society of Mechanical Engineers' consensus standard ASME B30.5-2007 Mobile and Locomotive Cranes (15, 16, 17, 18) This list is not a comprehensive description of all criteria to be considered when designing and implementing safe access systems, but is meant to suggest some important considerations. When purchasing equipment it is important to consult with the equipment's manufacturer or distributor about safe access systems designed for that particular equipment. After market access systems are available, but must fit the equipment, suit the user's needs, and incorporate elements of safe access design.

Some minimum criteria for mobile equipment and vehicle access systems:

- Components of the access system should be placed to allow and encourage the user to follow the three-points of contact method and face toward the equipment while ascending/descending or mounting/dismounting.
- Be placed to the best advantage for supporting and controlling body weight and movement.
- Be obvious as to proper usage without special training.
- Minimize protrusions that could cause a user to trip.
- All surfaces of the system should be non-slip.

- The shortest expected user should be able to easily reach the first step from the ground.
- Two handholds or handrails (handrails are preferable) should be accessible to the shortest expected user from the ground and while ascending or descending.
- Handrails/handholds should be placed along the access system to provide continuous support so as to allow the user to maintain balance.
- Steps should be coordinated with properly positioned handrails and handholds so that three points of contact can be maintained.
- Handrails/handholds should have smooth surfaces.
- Step design should provide the user with natural foot placement or should be clearly visible to the user while descending.
- Steps or rungs should allow the midpoint of the shoe, not just the toe, to rest solidly on the step or rung.
- Steps should be wide enough to stand on with both feet.
- Steps should be uniform in size and shape.
- Steps should be designed to allow minimal accumulation of mud and debris.
- The height and depth between steps should be uniform.

Recommendation #3: Employers should maintain mobile equipment access systems and walking and working surfaces in a safe and useable condition.

Discussion:

- Repair damaged components such as steps, ladders, handrails, or handholds.
- Ensure that walking and working surfaces of the equipment have anti-slip surfaces. Periodically check slip resistant coatings to ensure they are still functional.
- Keep walking surfaces free of oil, grease, mud, debris, and excessive dirt.
- Be aware of and remove accumulations of rainwater, ice, and snow.

Recommendation # 4: Employers should consider the safety needs of older workers.

Discussion:

As the working population of the U.S. continues to age and workers out of desire or necessity stay in the workforce longer it will be a challenge to maintain their ability to work. Older workers bring their considerable experience and expertise to the workplace and employers wish to attract and maintain such employees. Employers can take

measures to ensure that their employees as they age will still be able to perform their jobs. Many workers over the age of 50 have problems with balance, vision, lack of flexibility, instability of gait, and other health conditions which put them at risk of falling. Older workers are at higher risk of fatal falls, and workers 55 and older have the highest rate of fatal falls. The average height of fatal falls for older workers is about a third shorter than the average height at which younger workers die from falls. (19, 20)

In this case, mounting and dismounting from cranes and its various parts and other large mobile equipment can be made safer and easier for older workers by ensuring that there are adequate and properly designed steps and handholds/handrails which are placed so that they may be easily reached.

Recommendation # 5: Crane and mobile equipment designers and manufacturers should consider designing safer access systems for mobile equipment.

Discussion:

Design of mobile equipment access systems is a key factor in determining whether users are able to perform their work activities safely. Poorly designed systems are more likely to result in worker slips, trips, loss of balance, and falls. (2-14)

Equipment should be designed with systems to eliminate or minimize fall hazards. Equipment access steps, ladders, handrails, and handholds should be designed and placed in accordance with sound design principles taking into account the safety needs of all potential users. The design and placement of access system components determine how users will interact with them and whether their interactions result in easy and safe access to and from equipment or whether they result in unsafe actions or falls. Improvements in design are more effective than relying on changing worker behavior.

If key components of an access system are missing, cannot be safely reached, involve an awkward posture, provide inadequate footing or handhold, or require use of a part of the equipment not designed as part of the access system (such as stepping on a vehicle tire), then risk of potential injury to users is increased.

Further, risk taking behavior by workers, such as jumping down from equipment, may be the result of lack of or inadequate or poorly placed steps, handholds, and handrails. Mobile equipment access systems should include not only safely designed systems for cab access/egress, but access to all expected areas where workers may need to perform work, such as in this case mounting and dismounting from the crane turntable deck.

Designers and manufactures of mobile equipment are encouraged to adopt the principles of the National Institute for Safety and Health's "Prevention through Design" initiative (21) and the American Society of Safety Engineers' Prevention through Design guidelines (22) when creating access systems. The intent of this initiative is to encourage business leaders, designers, and manufacturers to "design out" or minimize hazards so as to prevent occupational injuries and fatalities. Manufacturers are encouraged to provide safe access systems as a standard part of their mobile equipment.

Recommendation # 6: Safety researchers should investigate the human factors issues involved in mobile equipment access systems.

Researchers have noted that current occupational health and safety regulations and consensus standards related to specifications for design and construction of safe access systems to large commercial vehicles and mobile construction equipment are incomplete, inadequate, vague, or non-specific, providing only general specifications and guidelines. (2-14) Access systems should be evaluated to accommodate the needs of the user. Research should be conducted on the personal characteristics, anthropometry, demographics, and injury experience of the user population so as to determine how best these systems may be designed to ensure user interaction with these systems will minimize the risk of injuries resulting from falls. The results of this research should be used to inform equipment designers and manufacturers, industry associations, standards boards, and occupational health and safety regulators.

REFERENCES

1. Washington Administrative Code. Safety Standards for Construction Work, Part L Cranes, Derricks, Hoists, Elevators, and Conveyors, Chapter 296-155-525 WAC Cranes and Derricks. http://www.lni.wa.gov/wisha/rules/construction/HTML/296-155L_1.htm
2. Health and Safety Executive. (2006). The underlying causes of falls from vehicles associated with slip and trip hazards on steps and floors. Research Report 437.
3. Moore, S.M., Porter, W.L., Dempsey, P.G. (2009). Fall from equipment injuries in U.S. mining: Identification of specific research areas for future investigation. Journal of Safety Research, 40:455-460.
4. Hirth, J., Khalil, T. (2004). The persistence of ergonomic design problems in entry/exit systems of elevated vehicles. Proceedings of IIE Annual Conference and Exhibition 2004, Houston, TX: 951-957.
5. MacCollum, D.V. (1993). Crane Hazards and Their Prevention. American Society of Safety Engineers, Des Plaines, IL.
6. Couch, D.B., Fraser, T.M. (1981). Access systems of heavy construction vehicles: Parameters problems and pointers. Applied Ergonomics, 12(2): 103-110.
7. Lin, L.-J., Cohen, H.J. (1997). Accidents in the trucking industry. International Journal of Industrial Ergonomics, 20:287-300.
8. Fathallah, F. (2006). “Falls during entry/egress from vehicles.” In Haslam, R., Stubbs, D. (eds.) Understanding and Preventing Falls. Taylor and Francis, New York, NY.
9. Hurst, R., Khali, T. (1984). Entering and exiting elevated vehicles. Professional Safety, Sept.: 20-26.
10. Zwahlen, H.T., Kim, D.S, Gerth, R.J (1995). An evaluation of mounting step dimensions and handhold/handrail dimensions on semi-trucks, agricultural, and industrial vehicles. Proceedings of the 39th Human Factors and Ergonomics Society 1995, San Diego, CA: 1028-1032.
11. Dickie, D.E., Campbell. (1982). Mobile Crane Manual. Construction Safety Association, Toronto, Ontario.
12. Washington State Department of Labor and Industries, SHARP Program. (2008). Preventing injuries in the trucking industry: Focus report 1997-2005. Washington State Department of Labor and Industries. Technical report number 90-17-2008.
13. Bottoms, D.J. (1983). Design guidelines for operator entry-exit systems on mobile equipment. Applied Ergonomics, 14(2):83-90.
14. Bentley, T. (2009). The role of latent and active failures in workplace slips, trips and falls: An information processing approach. Applied Ergonomics, 40(2): 175-180.

15. Woodson, W.E., Tillman, B., Tillman, P. (1992). Human Factors Design Handbook: Information Guidelines for the Design of Systems, Facilities, Equipment and Products for Human Use. McGraw-Hill, Inc., New York, NY.
16. Society of Automotive Engineers. (2003). SAE J185-2003 – Surface Vehicle Recommended Practice, Access Systems for Off-Road Machines.
17. International Organization for Standardization. (2006). ISO 2867:2006 Earth-moving Machinery – Access Systems.
18. American Society of Mechanical Engineers. (2008). ASME B30.5-2007 – Mobile and Locomotive Cranes – Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings.
19. Agnew, J. Suruda, A.J. (1993). Age and fatal work-related falls. Human Factors, 35(4): 731-736.
20. Silverstein, M. (2008). Meeting the challenge of an aging workforce. American Journal of Industrial Medicine, 51(4): 269-280.
21. National Institute for Occupational Health and Safety, Centers for Disease Control and Prevention. Prevention Through Design [web page]. http://www.cdc.gov/niosh/topics/ptd/
22. American Society of Safety Engineers. (2009). Prevention through Design: An ASSE Technical Report. TR-Z790.001-2009.

APPENDIX

Photo 1. Incident crane viewed from the right rear. At the time of the incident the cab was rotated approximately 30 degrees right.

Photo 2. Incident crane rear view. Victim fell from the right rear crane turntable deck.

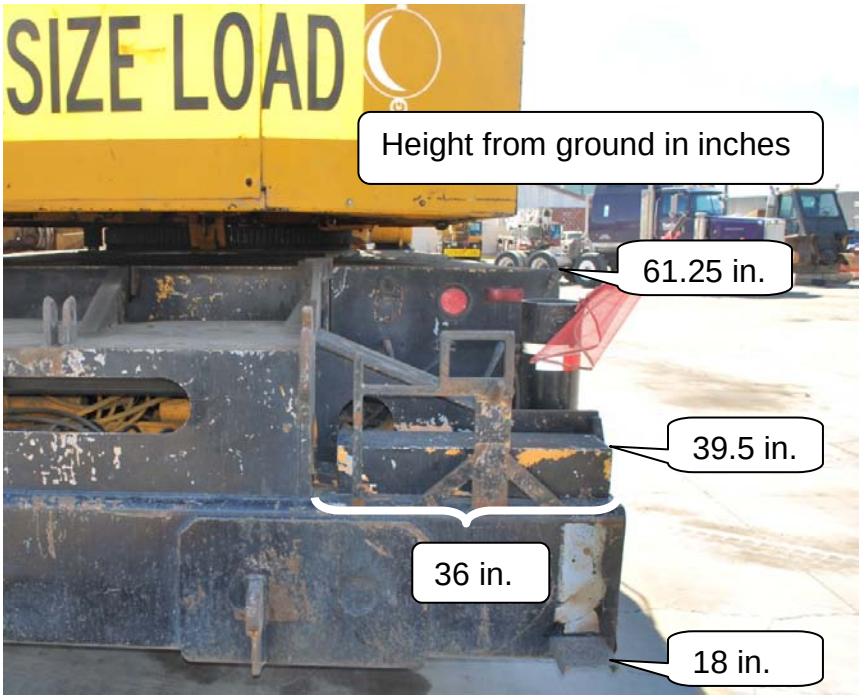

Photo 3. Right rear of the crane from where the victim fell, showing the access system step and turntable heights in inches.

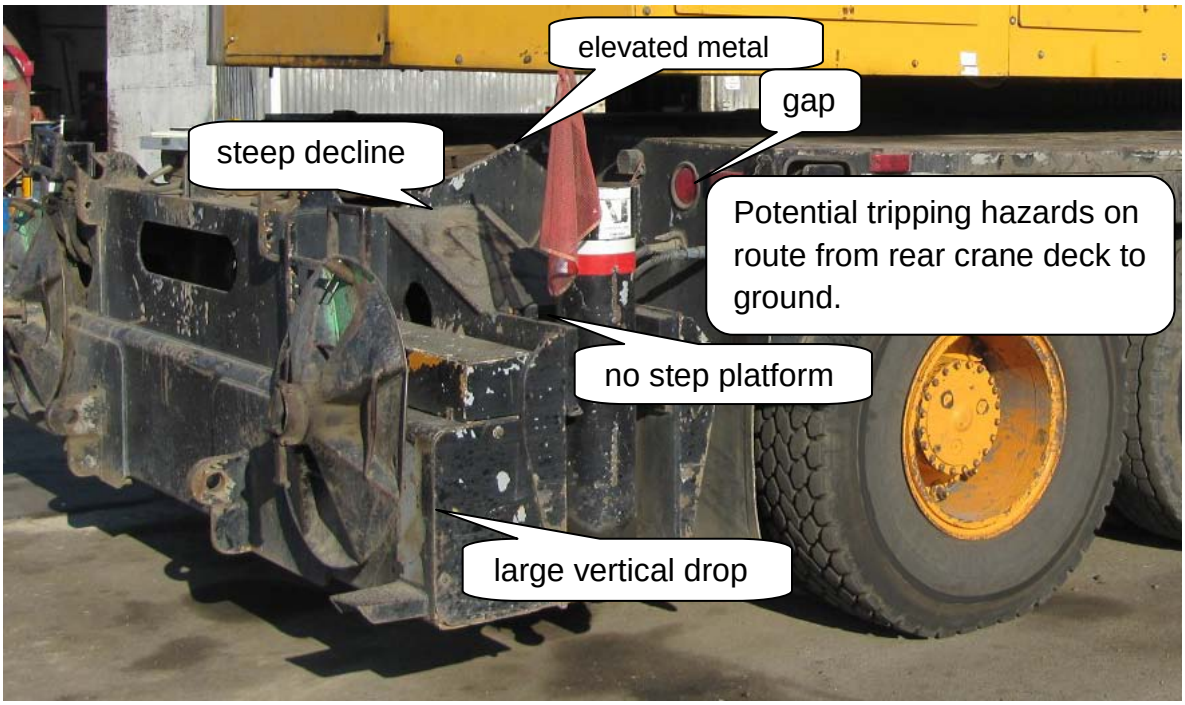

Photo 4. Configuration of the crane's rear right access system.

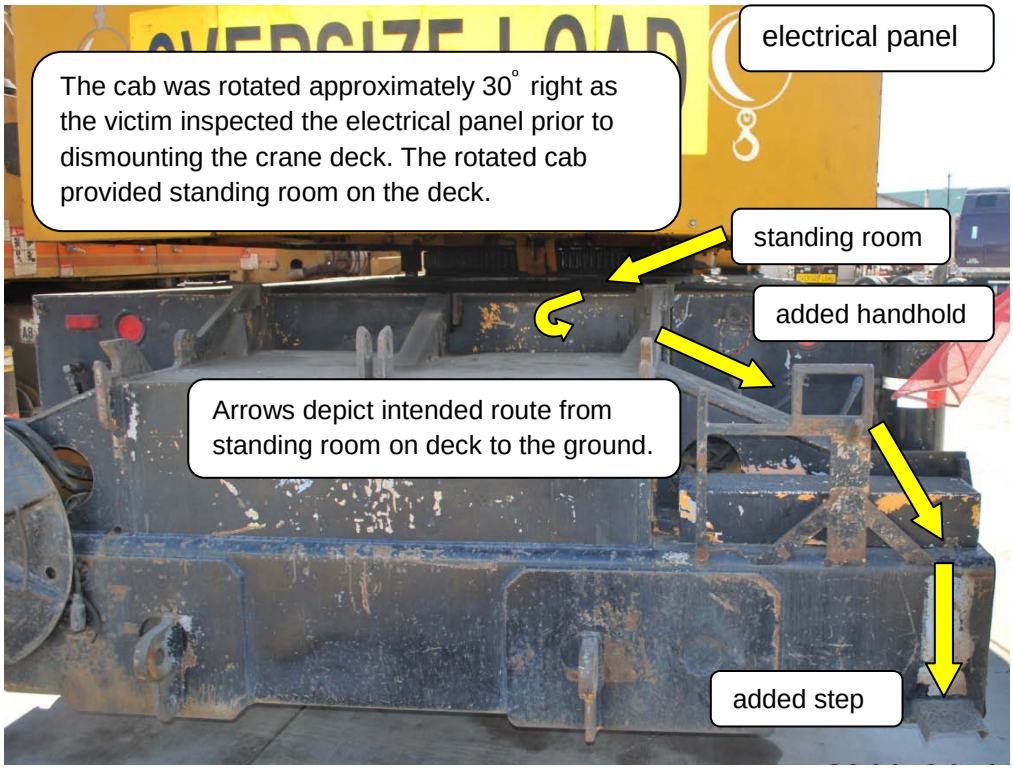

Photo 5. Configuration and features of crane's right rear access system and possible intended route used by the victim.

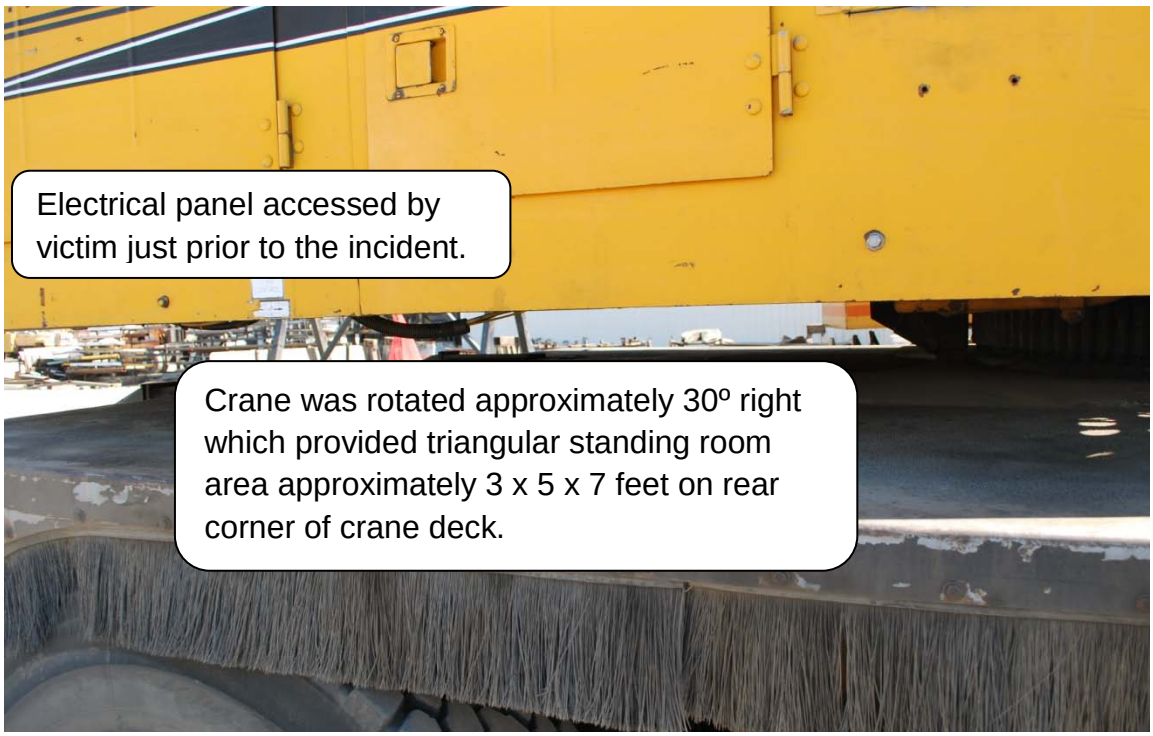

Photo 6. Crane's electrical panel and turntable deck.

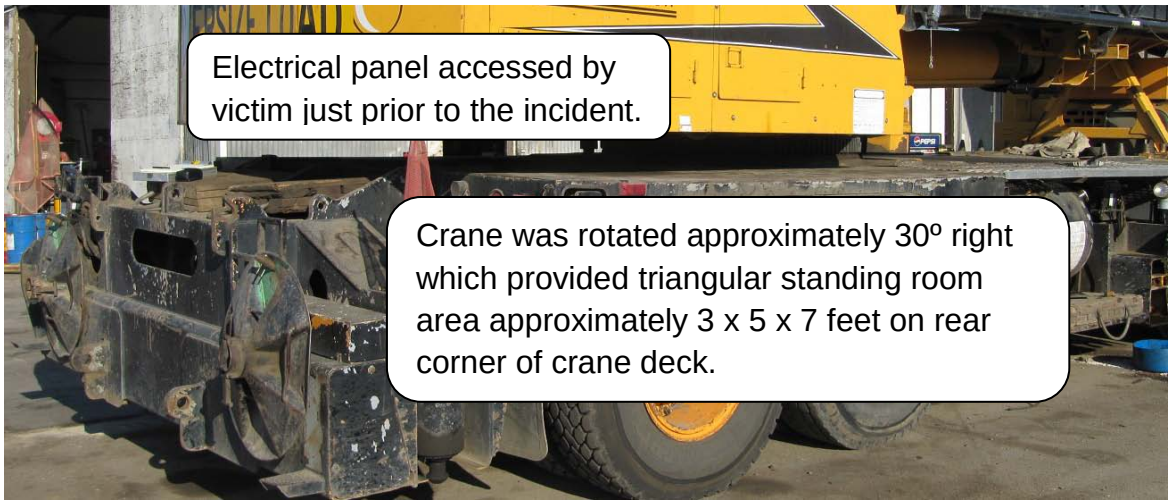

Photo 7. Crane's electrical panel and turntable deck.

Photo 8. Incident crane rear access system where victim fell.

Photo 9. Incident crane close-up of features of rear access system.

Photo 10. Incident location in parking lot of elementary school. Crane was backed into the parking stall in the upper middle of the photo.

Investigator Information

Todd Schoonover has a PhD in Industrial Hygiene from the University of Illinois at Chicago. He is a Certified Industrial Hygienist (CIH) and Certified Safety Professional (CSP). Todd is currently the Principal Investigator for the WA FACE program.

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Randy Clark has a BA from The Evergreen State College. He is a Research Analyst with the WA FACE program.

Washington State FACE Program Information

The Washington State Fatality Assessment and Control (WA FACE) program is one of many workplace health and safety programs administered by the Washington State Department of Labor & Industries' Safety & Health & Research for Prevention (SHARP) program. It is a research program designed to identify and study fatal occupational injuries. Under a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH), WA FACE collects information on occupational fatalities in WA State and targets specific types of fatalities for evaluation. WA FACE investigators evaluate information from multiple sources. Findings are summarized in narrative reports that include recommendations for preventing similar events in the future. These recommendations are distributed to employers, workers, and other organizations interested in promoting workplace safety. NIOSH-funded, state-based FACE programs include: California, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, New York, Oregon, and Washington. WA FACE does not determine fault or legal liability associated with a fatal incident. Names of employers, victims and/or witnesses are not included in written investigative reports or other databases to protect the confidentiality of those who voluntarily participate in the program.

Additional information regarding the WA FACE program can be obtained from:

Washington State FACE Program

www.lni.wa.gov/Safety/Research/FACE/default.asp

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