

**Crane-Related Deaths in Construction
and Recommendations for Their Prevention:
*Revised January 2009***

Introduction & Summary

On June 17, CPWR issued the report *Crane-Related Deaths in Construction and Recommendations for Their Prevention*, which analyzed Census of Fatal Occupational Injury (CFOI) data and recommended ways to make crane operation safer for workers and those living and working near cranes. CPWR began examining crane fatality data from the Bureau of Labor Statistics (BLS) in 2008 after three major crane incidents occurred within a 10-week period. The three incidents two in New York City and one in Miami caused the deaths of 10 construction workers and one bystander, and injured 19 construction workers, 11 first responders, and one bystander.

CPWR researchers decided to re-examine the data when further studies showed many deaths of workers struck by crane loads were not being counted under the primary CFOI Source code for “cranes.” Lead researcher, CPWR’s Director of Safety Research Michael McCann, Ph.D., culled through the CFOI narratives to obtain this data. Also, in light of the large number of crane-related fatalities during 2008, McCann gathered data from Internet sources on construction crane injuries and deaths that occurred from Jan. 1, 2008, to Dec. 31, 2008.

CPWR researchers compared the June report data to the recently completed data analysis and found the total number of deaths involving cranes nearly doubled, as did the annual average of crane-related deaths. The June report identified 323 deaths involving cranes and an annual average of 22 worker deaths. The revised report identified 632 deaths involving cranes from 1992 to 2006, or an average of 42 worker deaths annually. The most frequent cause of death remained overhead power line electrocutions. A tabulation of the cause of death, types of cranes involved in fatalities, and more information is described within the revised report.

Clearly, the safe operation of cranes could be improved. The efforts to improve crane safety and revise the 1971 Crane Standard have been in the works for years. In 2003, OSHA formed a Crane and Derrick Negotiated Rulemaking Advisory Committee (C-DAC) of representatives from industry, labor and government to develop a new safety standard for the construction industry to aid in reducing fatalities. The committee first met in July 2003, and reached a consensus on regulatory language for the new standard on July 9, 2004. Four years later and after considerable pressure, OSHA published the proposed crane and derrick rule for public comment in the Federal Register on Sept. 16, 2008, with a deadline for public comment of Dec. 8, 2008. This deadline was later extended to Jan. 22, 2009.

The attention and pressure to improve crane safety could be traced to the two crane collapses in New York City and Miami in March followed by another collapse in New York City. The deaths set off an alarm within the construction community and city dwellers living in the shadow of large scale projects. The March 15 crane collapse in New York City killed six construction workers plus a visitor in a residential building when the crane's boom crushed the side of that building. The scale of the disaster and death of a bystander garnered much media attention, as did the May 30 New York City crane collapse that killed two workers and injured a bystander. But injury and death to bystanders are not first-time occurrences. Selected examples of crane-related bystander deaths collected from news reports are included in Table 1.

CPWR offers this research and seven recommendations with a desire to heighten awareness of crane hazards and to minimize hazards through training, inspection and proper operation of these mammoth machines.

Report Authors

Michael McCann, PhD, CIH, is director of safety research at CPWR – The Center for Construction Research and Training, the research, development, and training arm of the Building and Construction Trades Department, AFL-CIO.

Janie Gittleman, PhD, MRP, is associate director of safety and health research for CPWR – The Center for Construction Research and Training.

Mary Watters is communications director for CPWR – The Center for Construction Research and Training.

Methods

Construction industry fatality data for the 2-digit BLS Standardized Industrial Classification (SIC) Codes 15, 16 and 17 for 1992 through 2002 were identified in the Census of Fatal Occupational Injuries (CFOI) database. For 2003-2006, the 2002 North American Industry Code System (NAICS) codes 236-238 were used. The resulting data were entered into a Microsoft Excel 2003 database for analysis.

Construction worker deaths related to cranes were identified by selecting all records with the Source and Secondary Source code 34* (Cranes). In addition, the construction record narratives were searched for the word “crane.” Records involving aerial lifts, and scissor lifts were excluded, but crane man baskets were included.

The CFOI narratives including event, occupation and establishment codes of the crane-related deaths were used to classify deaths by cause, occupation and establishment size. This report identifies the main causes of death, the types of cranes involved in fatal incidents, the trades of those who died, and the size of the employer experiencing the greatest number of fatalities.

Information on construction crane injuries and deaths from January through December, 2008, was gathered from the following Internet sources: CraneAccidents.com, Washington State Department of Labor and Industries, Google, Internet new articles, OSHA Underground, Cranes Today, and The Weekly Toll.

Results

1992-2006 CFOI Study

The revised study found a total of 632 crane-related construction worker deaths involving 610 crane incidents from 1992-2006, compared to a total of 323 deaths in 307 incidents in the previous study. The revised average is 42 deaths per year, with 18 multiple death incidents involving 40 deaths.

Four main types of cranes have been associated with crane-related fatalities. Of the 610 fatal crane incidents, only 375 could be identified from the record as to type of crane. Of these, 292 (78%) involved mobile or truck cranes. Forty-five of the fatal incidents involved overhead or gantry cranes (12%), 18 involved tower cranes (5%), and 11 involved floating or barge cranes (3%). The remaining nine reports involved other types of cranes..

Causes of death

The main causes of death in the original study were overhead power line electrocutions (32%), crane collapses (21%), and struck by crane booms/jibs (18%). Struck by crane loads only accounted for 7% of deaths. By contrast, in the revised study, while overhead

power line electrocutions remained on top (25%), struck by crane loads was the second highest cause of death (21%). **[NB in the first study struck by crane, struck by crane booms/jibs, and struck by other crane parts were separated. In this study, they were combined.]**

Overhead power lines electrocutions were the leading cause of crane-related deaths. Of the total 632 crane-related deaths, 157 were caused by overhead power line electrocutions (25%), 132 deaths were associated with workers being struck by crane loads, 125 deaths involved being struck by cranes, crane booms/jibs or other crane parts (20%), 89 deaths involved crane collapses (14%), 56 deaths involved falls (9%), and 30 deaths involved being caught in/between crane parts (5%). (See Table 2.)

Over half of all electrocutions (53%) were associated with the crane boom, cable or load/load line contacting an overhead power line. The rest involved contact of an overhead power line with unspecified parts of the crane. Table 3 describes worker activities leading to electrocutions. Those activities involved workers on foot touching or guiding the crane load or cables, workers operating the crane – including several operators who were electrocuted after jumping from the crane, and workers on foot touching the crane.

Struck by crane loads was the second leading cause of death. Of the 132 crane load deaths, 42 occurred while loading/unloading (32%), 19 while flagging/directing/guiding the crane load (14%), nine while operating the crane (7%), and 20 involving other crane-related work (15%). Forty-two deaths involved workers not involved with crane work (32%).

The major cause of struck by load deaths was load-related problems, causing 53 deaths (40% of struck by load deaths). In about half of these (25 deaths), the load came loose from the rigging and fell. In a quarter of these (13 deaths), the load shifted or rotated and struck a worker. In a fifth of the cases (10 deaths), the load came loose and struck the rigger while being loaded or unloaded.

Rigging problems caused 36 deaths (26%). In half of the cases (18 deaths), a cable broke or sling strap came loose. In one-third of the cases (11 deaths), load straps/braces/buckles/safety latches/sling clips failed or broke.

Crane problems caused 12 deaths (9%). In most cases, the crane load struck a worker when the crane turned or tilted or otherwise lost control of the load. In 31 deaths (23%), the case narratives gave no indication as to why loads struck workers.

Struck by crane or crane part was the third leading cause of death. Of the 125 deaths, 64 involved being struck by falling crane booms/jibs. Of these, 36 deaths involved dismantling the boom (56%), six involved lengthening the boom (9%), eight involved breaking of the boom or boom cable (13%), and 14 involved other causes (22%).

Crane collapses were the fourth leading cause of death. An unstable, uneven or icy surface on which the crane was sitting accounted for 12 fatalities (15%). Overloading the crane accounted for another 10 deaths (12%). In seven cases (9%), the crane load or

boom shifted. In 56% percent of the reported cases, there was not enough information provided to ascertain the cause in the narrative. Of the 81 crane collapses, 34 involved mobile cranes.

Trades Involved

Construction laborers experienced 191 crane-related deaths between 1992 and 2006 (30%), followed by 101 deaths of heavy equipment operators (16%), which included 62 crane and tower operators. In addition, 86 supervisors/managers/administrators died in crane-related incidents (14%), as did 42 ironworkers (7%), and 41 carpenters (6%). Other trades with fewer numbers of deaths included welders and cutters, electrical workers, mechanics, sheet metal workers, and truck drivers (totaling 27%).

Overall, 188 of the 632 construction workers (30%) were employed by subcontractors with fewer than 10 employees. One hundred and eight individuals (17%) worked for employers with over 100 employees. Twenty-nine of the construction workers who died on the job were self-employed (5%).

January through December, 2008 Construction Crane Injuries and Deaths

An Internet search from January through December 2008, revealed a total of 97 construction crane incidents involving injuries and deaths. There were a total of 54 deaths and 100 injuries of construction workers in 88 incidents, and four deaths and 26 injuries of non-construction workers (15 bystanders and 11 rescue workers) in 15 incidents. These incidents involved 88 mobile cranes, 7 tower cranes, and 2 other cranes.

The causes of 88 incidents resulting in construction worker deaths and injuries were:

- 34 crane collapses (39%), involving 25 deaths and 59 injuries
- 12 struck by crane load incidents (14%), involving six deaths and 10 injuries
- 12 overhead power line contacts (14%), involving 10 deaths and eight injuries
- 10 struck by other crane part incidents (11%), involving six deaths and seven injuries
- 20 other causes (21%) – including seven highway incidents, six falls, three caught in/between, three struck by non-crane falling objects, and one struck by lightning. These incidents resulted in seven deaths and 16 injuries.

The causes of the 15 incidents resulting in bystander deaths and injuries were:

- six highway collisions (40%), involving one death and six injuries

- four crane collapses (27%), involving three deaths and 14 injuries (including 11 rescue workers)
- three other causes (20%), involving two work zone collisions and one struck by falling crane boom, resulting in four injuries.

The 97 crane incidents involving deaths and injuries occurred in 35 states, with deaths occurring in 28 states. New York, Texas and Florida had 32 crane incidents that resulted in 23 deaths and 56 injuries of construction workers, and one death and four injuries of bystanders, and 11 injuries of rescue workers (in the March 15 New York City tower crane collapse).

Conclusions and Recommendations

The findings of these analyses indicate the number of crane-related deaths and injuries is significant, and do not only involve construction workers but can involve bystanders. The main causes of worker deaths were electrocution, struck by crane parts or crane loads, or crane collapse. More than half of the deaths were among workers in two trades: construction laborers and heavy equipment operators. Employees working for small contractors represent a large portion (about one-third) of the total number of deaths. Most crane-related deaths involved mobile cranes.

Possible explanations for these findings are a lack of worker and supervisor training, lack of jobsite safety plans, lack of adequate crane inspections, and lack of proper investigation and reporting of crane accidents and fatalities.

Specific recommendations to reduce and prevent future injuries and fatalities are as follows:

First, crane operators should be certified by a nationally accredited crane operator testing organization, such as the National Commission for the Certification of Crane Operators (NCCCO)*. Presently only 15 states and a few cities[§] (including New York City) require certification or licensing of crane operators, and some have their own certification program. We recommend that states and cities should require certification by a national certification organization for reasons of standardization of qualifications and to promote the transfer of credentials between states.

Second, riggers who attach the load to the crane and signal persons who visibly or audibly direct the crane operator on where to place the load should be adequately trained and tested. NCCCO will in the future offer certifications for these types of workers.

Third, crane inspectors should be certified. OSHA requires that employers designate a competent person[¶] to inspect machinery and equipment prior to each use, and during use, to make sure it is in safe operating condition [29 CFR 1926.550(a)(5)]. OSHA also requires annual inspections. For the maritime industry, OSHA accredits

crane certifiers through an examination (29 CFR Part 1919). However, since inadequate inspections have been implicated in work-related crane deaths, we recommend that crane inspectors should have the same degree of qualification as crane operators.

Fourth, in addition to other mandated inspections, cranes must be inspected thoroughly by a certified crane inspector after being assembled or modified, such as the “jumping” of a tower crane.

Fifth, according to the proposed OSHA consensus standard on cranes, only trained workers should assemble, modify or disassemble cranes, and they should always be under the supervision of a person meeting both the definition of qualified person** and competent person specified in the standard. In many instances, especially with rented cranes, there are no trained personnel present when cranes are set up and dismantled. This issue must also be addressed.

Sixth, crane loads should not be allowed to pass over street traffic. If rerouting is not possible, then streets should be closed off when loads pass over streets and pedestrian walkways. Presently crane loads are not allowed to pass over construction workers.

Seventh, more complete reporting of data, particularly after a crane collapse, is necessary. OSHA and the industry should conduct more thorough investigations of crane-related fatalities and capture more complete data in its reporting system.

* Such certification organizations should be accredited by a nationally recognized accrediting organization such as the American National Standards Institute (ANSI), should administer written and practical tests to determine the knowledge and skills of the applicant, and meet other standard accreditation criteria.

‡ California, Hawaii, Minnesota, Montana, Nevada, New Jersey, New Mexico, Utah, Washington (as of 2010), and West Virginia require or recognize NCCCO certification of crane operators as part of their state licensing program. Connecticut, Massachusetts, New York, Oregon, and Rhode Island have their own licensing programs. Among cities, New Orleans, New York, and Omaha, Neb., require or recognize NCCCO certification of crane operators; Chicago, Los Angeles, and Washington, D.C., have their own licensing program.

∇ A competent person, according to OSHA, is one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees, and *who has authority to take prompt corrective measures* [italics added for emphasis] to eliminate them. [29 CFR 1926.32(f)]

** A qualified person means a person who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated the ability to solve/resolve problems relating to the subject matter, the work, or the project.

References

Jamieson, R. [2006]. "The Fall and Rise of a Crane Operator." *Seattle Post-Intelligencer*, Dec. 14.

Kates, B. [2008]. "Pain of the Cranes." *New York Daily News*, March 24.

Kilborn, P. [1989]. "San Francisco Crane Collapse was no Fluke." *New York Times*, Dec.17.

LaBar, G. [1999]. "Three Workers Die When "Big Blue" Falls at Stadium." *Occupational Hazards*, July 15.

MSNBC staff. [2008]. "Crane Collapse Kills Two and Unsettles New Yorkers," May 31.
www.msnbc.msn.com/id/24889155/print/1/displaymode/1098/ (Accessed May 30, 2008.)

OSHA [1990]. *Analysis of Construction Fatalities – the OSHA Database 1985-1989*. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

Walter, L. [2008]. "Miami Crane Collapse Kills 2, Injures 5." *Occupational Hazards*, March 6.

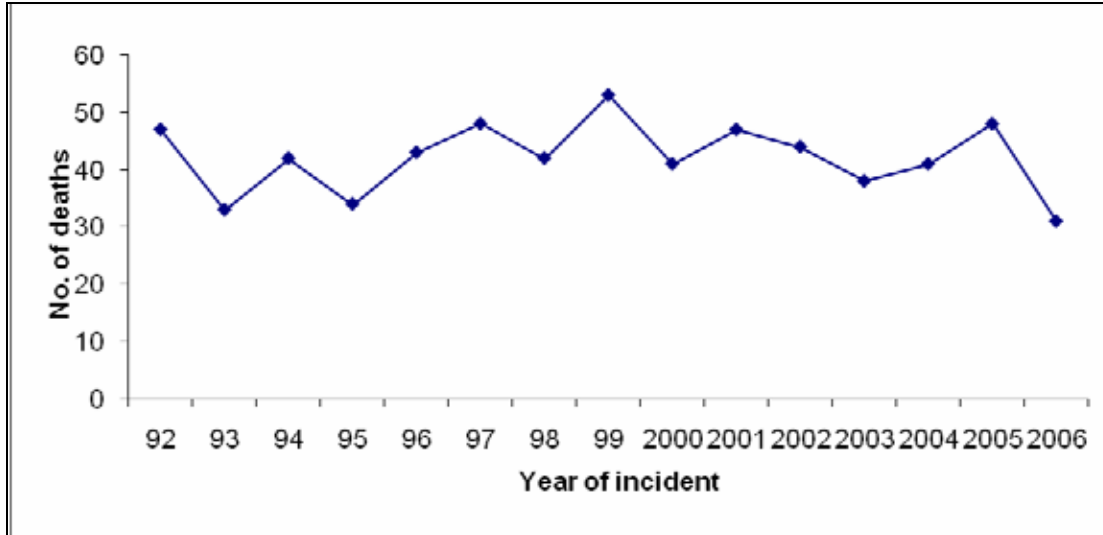
Ward, K. [2008]. "'It Was Gone': String of Problems Led to 51 Deaths at Willow Island." *The Charleston Gazette*, April 27.

Ware, P. [2008]. "OSHA Begins Investigating Crane Collapse in New York that Killed Seven, Injured 24." *BNA OSH News*, March 20.

Table 1. Examples of Fatal Crane Incidents

<u>Date</u>	<u>Location</u>	<u>Description</u>
4/27/78	Willow Island, WV	Crane lifting bucket of cement collapsed onto scaffold inside cooling tower. Construction workers: 51 dead Source: [Ward, 2008]
11/29/89	San Francisco, CA	Tower crane fell 16 stories while being jumped. Construction workers: 4 dead Bystanders: 1 dead; 22 injured Source: [Kilborn, 1989]
11/14/99	Milwaukee, WI	“Big Blue” tower crane collapsed at stadium and struck three workers in a crane basket. Winds 25-30 mph. Construction workers: 3 dead Source: [LaBar, 1999]
9/29/06	New York, NY	4-ton chunk of steel fell from crane crushing a taxi. Bystanders: 5 injured Source: [Kates, 2008]
11/16/06	Bellevue, WA	Crane collapsed on a condo. Construction workers: 1 injured Bystanders: 1 dead Source: [Jamieson, 2006].
3/15/08	New York, NY	Tower crane collapsed while being jumped, damaging several buildings. Construction workers: 6 dead, 13 injured Bystanders: 1 dead, 11 first responders injured Source: [Ware, 2008]
3/25/08	Miami, FL	20-foot section crane fell 30 stories while jumping the crane. Construction workers: 2 dead, 5 injured Source: [Walter, 2008]
5/30/08	New York, NY	Crane cab, boom, and machine deck separated from the tower mast and collapsed onto the street Construction workers: 2 dead, 1 injured Bystanders: 1 injured Source: [MSNBC staff, 2008]

Figure 1. Crane-Related Deaths in Construction by Year, 1992-2006*



* Data from 2006 are preliminary; data from 1992-2005 are revised and final.

Source: U.S. Bureau of Labor Statistics Census of Fatal Occupational Injuries Research File

Table 2. Causes of crane-related deaths in construction, 1992-2006

<i>Cause of death</i>	<i># deaths</i>	<i>%</i>
Overhead power line electrocutions	157	25%
Struck by crane loads	132	21%
Struck by crane or crane parts*	125	20%
Crane collapses	89	14%
Falls**	56	9%
Caught in/between	30	5%
Other causes***	43	7%
Total	632	****

* Involved 18 cranes (including 13 run-over by mobile crane), 78 crane booms/jibs (64 due to falling booms/jibs), and 29 other crane parts

** Includes 21 falls from crane bodies, 9 from crane baskets, 8 from crane loads and 18 other falls.

*** Other causes include 12 highway incidents and 11 struck by objects other than crane loads or parts.

****Does not add to 100 due to rounding.

Source: U.S. Bureau of Labor Statistics Census of Fatal Occupational Injuries Research File

Table 3. Activity of construction workers electrocuted by overhead power lines, 1992-2006

<i>Contact with overhead power lines</i>	#	%
Worker on foot touching/guiding load or cables	81	52%
Operating crane*	40	25%
Worker on foot touching crane	20	13%
Other**	16	10%
Total	157	***

* Includes 7 deaths of operators who jumped from crane

** Includes 6 deaths of workers on foot near but not touching crane

*** Does not add to 100% due to rounding.

Source: U.S. Bureau of Labor Statistics Census of Fatal Occupational Injuries Research File

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