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Deaths in construction related to personnel lifts, 1992–1999

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Abstract

Problem: This study examined deaths of construction workers due to personnel lifts (boom-supported and scissor lifts, suspended scaffolds, and crane platforms). *Methods*: Deaths of construction workers for 1992–1999 were examined using data from the Census of Fatal Occupational Injuries, a Bureau of Labor Statistics database. *Results*: The study identified 339 deaths: 42% from boom-supported lifts; 26% from suspended scaffolds; 19% from scissor lifts; 5% from crane platforms; and 7% from unapproved lifts (e.g., forklift platforms). The main causes of death were falls (36%), collapses/tipovers (29%), and electrocutions (21%). *Discussion*: Recommendations include: following OSHA regulations, wearing personal fall protection equipment, adequate maintenance, inspection before use, and training on the model of lift used. Precautions are also needed to prevent contact with overhead power lines. *Impact on industry*: The increasing popularity of boom-supported lifts and scissor lifts, both in construction and other industries, make their safety an important issue.

Keywords: Surveillance; Aerial lifts; Suspended scaffolds; Construction; Crane platforms

1. Problem

Personnel lifts include boom-supported lifts (e.g., vehicle-mounted elevating and rotating work platforms, bucket trucks, cherry pickers, articulating and telescoping boom lifts, telescopic derricks with personnel platforms), vertical lifts (e.g., scissor lifts, platform lift trucks, order pickers), suspended scaffolds (e.g., swing stages, boatswain's chairs), crane platforms, communication tower personnel hoists, and elevators/personnel hoists. Boom-supported lifts and vertical lifts are commonly called aerial lifts or aerial devices, although the Occupational Safety and Health Administration (OSHA) considers vertical lifts as mobile scaffolds. In addition, mobile equipment such as forklifts with unapproved scaffold platforms, front end loaders, and backhoes are sometimes improperly used to lift workers.

There have been few studies of injuries and deaths related to lifting of personnel, and most of these have been investigations of selected deaths, such as National Institute for Occupational Safety and Health (NIOSH) Fatal Accident Circumstances and Epidemiology (FACE) Reports rather than surveillance studies (National Safety Council, 1968; National Institute for Occupational Safety and Health [NIOSH], 1985, 1986, 1992a, 1992b, 1992c, 1992d, 1994, 1996a, 1996b, 1996c). In 1979, OSHA published a report on falls from scaffolds (OSHA, 1979). The report found that from 1974 to 1978, suspended scaffolds were involved in 27 deaths (25 incidents) out of a total of 87 scaffold fall deaths (82 incidents); 17 of these incidents involved equipment failure. In 1991, OSHA published a report on 34 fatal incidents involving 35 deaths from 1986–1990 related to vehicle-mounted elevating and rotating work platforms (OSHA, 1991). One-third of the incidents involved failure of equipment or were material or facility related. Falls and electrocutions each accounted for 40% of the deaths. Both of these OSHA studies included all industries. In 2000, NIOSH summarized surveillance findings and FACE Reports on workers deaths from falls (NIOSH, 2000). A 2001 NIOSH Alert on telecommunication towers identified 118 deaths from 1992 to 1998 using the Census of Fatal Occupational Injuries (CFOI), a Bureau of Labor Statistics database (NIOSH, 2001a). These deaths were from 93 falls, 18 tower collapses, and 4 electrocutions; many of these deaths were related to the use of hoists for lifting workers several hundred feet. Another NIOSH Alert on forklifts using the National Traumatic Occupational Fatalities

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(NTOF) Surveillance System identified 1,021 deaths from 1980 to 1994, 9% of which involved falls from forklifts (NIOSH, 2001b).

A Center to Protect Workers' Rights (CPWR) surveillance study of fatal falls in construction during 1997 found that aerial lifts were involved in 18 (5%) of 364 fall deaths identified from CFOI data (McCann & Chowdhury, 2000). A CPWR study of elevator and escalator injuries and deaths identified 152 deaths, almost all elevator-related, based on CFOI data from 1992–1998. Of these, 44 were work-related passenger deaths, and the rest due to working on or around elevators or escalators (McCann, 2001).

This article examines the detailed causes of deaths among construction workers related to personnel lifts for the years 1992–1999, as identified by CFOI. Elevator-related and telecommunication tower deaths were excluded because of the recent studies on these topics.

2. Methods

Construction industry fatality data for the 2-digit Standardized Industrial Classification (SIC) Codes 15, 16, and 17 for the eight years from 1992 through 1999 were identified in the CFOI database. The resulting data were entered into a Microsoft Access 97 database.

Deaths related to falls from suspended scaffolds were identified by selecting all records involving the BLS *Event* code 116 (Fall from scaffold, staging) and searching them manually for falls involving suspended scaffolds. Deaths from aerial lifts, particularly scissor lifts, were also included in this category. Other deaths related to personnel lifts, including deaths from causes other than falls, were identified by searching the remaining CFOI records using the keywords "aerial," "cherry picker," "scissor," "lift," "bucket," "basket," "crane," and "scaffold." The resulting records were screened to eliminate unwanted injuries (e.g., forklift collisions). Deaths where the injury occurred prior to 1992 were eliminated. This resulted in a total of 339 personnel lift deaths.

Relying primarily on the narratives and *Source* codes for each case, personnel lifts were classified in this study into the following categories: boom-supported lifts, vertical lifts, suspended scaffolds, crane platforms, and unapproved lifts. Manlifts and high-low platform lift trucks were classified as vertical lifts unless the narrative indicated that they were boom-supported lifts.

In this study, the causes of the personnel lift deaths were classified into the following categories: falls, collapses/tipovers, electrocutions, struck by/against, caught in/between, and fires. Deaths listed in CFOI as falls were classified as collapses/tipovers if the death was due to the collapse or tipover of the personnel lift. The cause of death was classified as a fall or collapse/tipover if that was the precipitating event, even if the death resulted from, for example, drowning or subsequently being run over by the personnel lift. Deaths where the year of the injury differed from the year of death were classified by the year of injury.

Analyses are primarily descriptive. Comparative analyses (e.g., between types of personnel lifts) are based on *proportions*, not rates, because denominator information is not known for the number of workers using the various types of lifts.

3. Results

Between 1992 and 1999, a total of 339 deaths in construction related to the use of personnel lifts were identified from CFOI data—an average of 42 per year (Table 1). The personnel lifts most frequently involved in these deaths were boom-supported lifts, suspended scaffolds, and scissor lifts. The major causes of death were falls, collapses/tipovers, and electrocutions.

Event codes for falls (119-Fall to lower level, n.e.c.; 118-Fall from non-moving vehicle; and 116-Fall from scaffold, staging) accounted for 86% of the fall deaths and 70% of the collapse/tipover deaths. *Event* codes 021 (Struck by falling object) and 4,233 (Overturned-Non-highway accident) accounted for 14% of the collapse/tipover deaths.

Table 2 shows that the major trades involved in the personnel lift deaths were electrical workers (electricians, electrical power installers and repairers, and their supervisors and apprentices), construction laborers, construction and maintenance painters, ironworkers, and carpenters. Construction and maintenance painters, and construction laborers predominated in suspended scaffold deaths.

Fig. 1 shows the number of deaths due to boom-supported lifts, suspended scaffolds, and vertical lifts by year of injury. The number of deaths from boom-supported lifts and vertical lifts increased from 1992 to 1999 (boom-supported lifts: slope = 1.19, p-value = 0.05115; vertical lifts: slope = 1.0, p-value = 0.0459). There was no apparent

Table 1
Causes of death related to personnel lifts among construction workers, 1992–99

Cause of death	Boom-supported lifts	Vertical lifts	Suspended scaffolds	Crane platforms	Unapproved lifts	Total
Falls	37	28	37	–	15	121
Collapses/ Tipovers	23	19	47	5	5	100
Electrocutions	62	7	–	–	–	72
Caught in/ between	11	–	–	–	–	18
Struck by/against	7	6	–	–	–	20
Fires	–	–	–	–	–	8
Total deaths	144	64	89	18	24	339

Note: Does not meet BLS publication criteria.
Source: U.S. Bureau of Labor Statistics data.

Table 2
Construction deaths related to personnel lifts by trade, 1992–99

Trade	Boom-supported lifts	Vertical lifts	Suspended scaffolds	Crane platforms	Unapproved lifts	Total
Electrical workers*	65	14	–	–	–	83
Construction laborers	17	15	19	–	7	62
Painters, construction and maintenance*	10	10	29	–	–	50
Ironworkers**	5	–	6	6	–	19
Carpenters*	5	–	5	–	6	17
Other trades***	42	24	28	5	9	108
Total	144	64	89	18	24	339

Note. – Does not meet BLS publication criteria.
Source: U.S. Bureau of Labor Statistics data.
* Includes supervisors and/or apprentices.
** Structural metal workers and welders and cutters.
*** Other trades included plumbers, pipefitters and steamfitters, brickmasons and stonemasons, and drywall installers.

change in deaths from suspended scaffolds from 1992–1999 (slope = – 0.154, p-value = 0.6330).

The data show differences in patterns of cause of death for the different types of personnel lifts.

3.1. Boom-supported lifts

Electrocutions accounted for 43% of deaths on boom-supported lifts, almost all involving contact with overhead power lines. One-third of the 62 electrocutions involved the bucket or the boom of the lift contacting an overhead power line. Half of the electrocutions involved direct contact of the worker with the overhead power line, mostly involving electricians or power installers working on the power lines.

Falls accounted for 26% of the boom-supported lift deaths. In half of the falls, the worker was ejected from the bucket as a result of either the worker or bucket being struck by objects or after the lift was struck by a vehicle. One-sixth of the falls occurred while the worker was transferring to or from the bucket at a height.

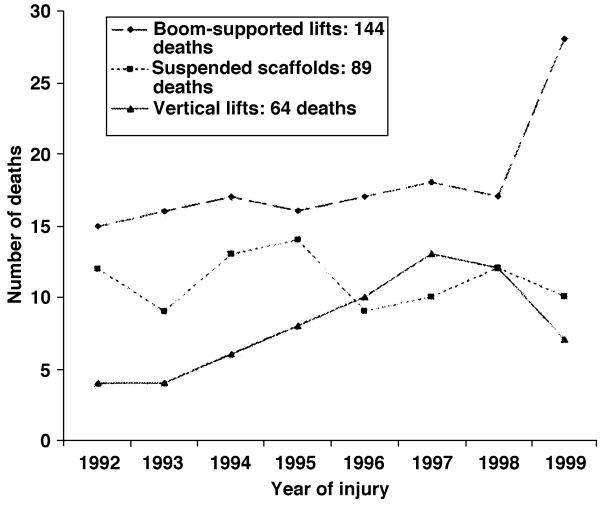

Fig. 1. Deaths from boom-supported lifts, suspended scaffolds and vertical lifts by year of injury, 1992–99. Source: U.S. Bureau of Labor Statistics.

Collapses/tipovers accounted for 16% of the boom-supported lift deaths. Almost one-third of these involved overturning of the lift. Two-fifths of these deaths involved the collapse of the boom, and one-quarter involved the collapse of the bucket. The CFOI narratives didn't describe causes for these collapses/tipovers in most of the instances.

Most of the 11 caught in/between deaths were caused by the worker being caught between the bucket edge and an object such as roof trusses or joists and beams. These often resulted when the lift bucket moved suddenly. The seven struck by/against deaths mostly involved the worker being struck by collapsing materials or object such as girders.

3.2. Vertical lifts

Falls accounted for 44% of the vertical lift deaths, almost all involving scissor lifts. The causes of the falls were not listed for 17 of the 29 fall deaths. In five of the deaths, the worker was thrown from the scissor lift, usually after being struck by an object. The other fall deaths involved removal of the entrance chains or railings of the platform, or standing on or leaning over the railing.

Tipovers of scissor lifts involved 30% of the vertical lift deaths, mostly occurring while the lift was extended at least 15 feet. One-quarter of the tipovers resulted from a lift in motion hitting a hole or driving over the edge of elevation changes.

Electrocutions accounted for 11% of the vertical lift deaths, almost half involving overhead power lines.

3.3. Suspended scaffolds

A total of 89 deaths from suspended scaffolds were identified from 1992–1999; 84 of them were falls or collapses resulting from falls. There were six multiple death incidents. For the same period, there was a total of 473 fatal scaffold falls, including collapses.

Collapses accounted for 53% of the suspended scaffold deaths, causing 47 deaths in 41 incidents. Breaking of a suspended rope caused 16 (40%) of the collapses. Other

causes of collapses included collapsing of the scaffold platform, improper connection or malfunctioning of the anchor or rigging system. Ten deaths from collapses (21%) were of unknown cause.

Falls accounted for 42% of the deaths. Ten of the 37 deaths (27%) involved falls when the scaffold tipped or moved. Tipping occurred mostly after the scaffold was struck by falling objects or wind. Fifteen deaths (41%) were of unknown cause.

Overall, 7 of the 84 fall/collapse deaths (8%) involved malfunctioning of fall arrest harnesses.

3.4. Other personnel lifts

There were 18 deaths in 14 incidents due to crane platforms. The main causes were collapses (28%), falls (22%), and struck by (17%).

Falls from unapproved personnel lifts, such as the forks of forklifts or from unapproved platforms such as pallets or boxes mounted on the forks, accounted for 15 of the 24 unapproved lift deaths (63%). Five of these deaths involved the platforms and workers falling off the forklifts. Tipovers of forklifts with workers on unapproved platforms accounted for 5 of the 24 deaths (21%).

4. Discussion

This study is the first detailed analysis of deaths in construction due to personnel lifts. It uses the BLS data from CFOI rather than the Annual Survey of Occupational Injuries and Illnesses, which is less complete than CFOI data. CFOI data, for example, include self-employed workers while the injury and illness data do not.

This study is strictly limited to the BLS definition of the construction sector, using SIC codes 15, 16, and 17. As such, it does not include the deaths of employees in the public utilities, a major group of users of bucket trucks, since public utilities include SIC codes 491–497. In contrast, the OSHA definition of construction is based on activity rather than SIC codes, and includes installation and repair activities. However, the results of this study have major implications for users of personnel lifts in other industries as well, including general industry, agriculture, mining, and maritime.

As mentioned in the Methods section, the data are based on proportions not rates, since denominator data are not available for the various types of lifting devices. To put the results in some perspective, the overall rate of death from injuries for construction in 1999 was 13.7 deaths per 100,000 full-time equivalent workers (FTE; Center to Protect Workers' Rights, 2002). For falls the rate was 4.2 per 100,000 FTE, and for electrocutions 1.5.

Although CFOI is the most complete compilation of work-related deaths, one problem is that many of the cases do not have much detail on the circumstances involved in the deaths. NIOSH FACE Reports, on the other hand, provide extensive details on selected cases but cannot be used for statistical purposes because of their limited scope.

4.1. Boom-supported lifts

There were a total of 144 deaths due to boom-supported lifts from 1992–1999, about 18 per year. The 1991 OSHA study reported 35 such deaths in the five years 1986–1990, about seven per year. The OSHA counts are incomplete because only deaths from those states where federal OSHA did inspections (about half the states) were included, and self-employed workers (about one-quarter of the construction work force) were excluded. However, given the large increase in the use of boom-supported lifts in the last decade, it appears that the number of boom-supported lift deaths has not dropped.

The large number of electrocutions of workers on boom-supported lifts (62 out of 144–43%) points out the hazard of working on or near energized overhead power lines. The fact that half of these electrocutions were among electrical workers (electricians and power installers, and their apprentices and supervisors) working on the overhead power lines indicates the need for de-energizing, if possible, or better training and precautions such as the use of proper personal protective equipment and insulated tools when working on energized lines.

Many of the electrocutions occurred, however, when an uninsulated lift bucket or part of a worker's body accidentally contacted an overhead power line. This usually happened when the bucket was being moved or when the worker was too close to an energized overhead power line. For non-electrical workers, a distance of at least 10 feet from overhead power lines should be maintained if the line cannot be de-energized or insulated.

Falls (excluding collapses) caused one-quarter of the boom-supported lift deaths, mostly due to a catapulting effect when the lift, boom, or bucket was struck by a vehicle, the bucket was struck by an object, or the boom suddenly moved. The use of personal fall protection systems would have stopped or prevented most of these falls. American National Standards Institute (ANSI) standards A92.2 and A92.5, which cover boom-supported lifts (ANSI, 1991, 1993) require that body belts or harnesses be worn when operating the aerial lift. OSHA requires wearing of harnesses or body belts in boom-supported lifts conforming to ANSI A92.2 in SubPart M (29 CFR 1926.453). SubPart M does not allow body belts in a fall arrest system (29 CFR 1926.502(d)), but does allow them as part of a restraint or positioning system (Swanson, 1998). Boom-supported lifts are also regulated under 1926.453 (Swanson, 2001). Scissor lifts are regulated by OSHA as mobile scaffolds (29 CFR 1926.452(w) and 1926.451; Swanson, 2000).

Full-body harnesses with lanyards and proper anchors can arrest falls. It is necessary to ensure that the aerial lift

cannot tip over from the arresting forces generated when a worker falls while wearing a personal fall arrest system (Swanson, 1999). This is also a concern with platforms that are extended horizontally beyond the base of the aerial lift. If the lift cannot withstand the arresting force, then a harness or body belt with a short lanyard as a restraint device should be used, with the lanyard and anchor so arranged that an employee cannot fall to a lower level. Restraint systems are preferred in general because they prevent falls, as opposed to arresting them.

Transferring to or from an aerial lift at a height also requires fall protection if there is a chance for the worker to fall (Gurnham, 1995). Ideally the lift bucket should rest on a roof or other stable surface. If this is not possible, when disembarking, the worker should tie off to a proper anchor on the structure before untying his or her lift lanyard.

This study didn't show the cause of most of the collapses and tipovers. The 1991 OSHA study implicated improper extension of outriggers or defective outrigger controls as the cause of all but one of the tipover deaths. Failure of hydraulic systems was a main cause of boom collapses. These incidents clearly show the need for better maintenance and inspection of aerial lifts before use. The OSHA study also implicated defective or inoperative controls or poorly labeled controls to be a contributing factor in several deaths.

The growing popularity of boom-supported and other aerial lifts could lead to increased numbers of deaths if preventive action is not taken. Today the most popular boom-supported lifts are 60-foot high telescopic boom lifts with 50 to 60 feet of horizontal reach and 45-foot articulating lifts with 24 feet of horizontal reach (Grubenau, 1999). However contractors are looking for lifts with even higher reaches and models are available that can go as high as 120 feet for telescopic lifts and 150 feet for articulating lifts (with 80 feet of horizontal reach). In addition, there is increasing use of aerial lifts for purposes not intended by the manufacturer. In particular, using them to lift loads plus personnel can exceed the lift's load capacity. Clearly, these trends increase the risk, especially of overturns.

Safety features such as self-leveling platforms, tilt alarms, stops on booms to prevent overreaching, and outrigger interlocks to prevent boom operation if the outriggers are not deployed are available on some models but are not standard. They are not required by ANSI or OSHA. Further research is needed on the stability of boom-supported lifts, especially the newer models, under various conditions.

Because most contractors rent the aerial lifts rather than buy them, workers may be using different models of aerial lifts from job to job, depending on what is available. There is concern about how well rental companies maintain aerial lifts since when a lift comes back, there is economic pressure to rent it out again as soon as possible. In addition, since controls are not standardized from manufacturer to manufacturer—or even in different models from the same manufacturer—workers need to be trained in the particular model they will be using.

4.2. Vertical lifts

Vertical lifts, mostly scissor lifts, caused 64 deaths—8 per year. According to the CFOI narratives, the causes of falls from scissor lifts was unknown for 62% of the falls; and in 18%, falls were due to the scissor lift being struck by objects. Likely causes of scissor lift falls are missing guardrails or chains, standing on guardrails, and/or leaning over too far. OSHA regulates scissor lifts as mobile scaffolds (29 CFR 1926.452(w)), and does not require personal fall protection if guardrails are present (Swanson, 2000).

Some manufacturers provide anchor points on scissor lifts. Only anchorages installed or approved by the manufacturer may be used. One major manufacturer of scissor lifts recommends full body harnesses with lanyards attached to a lanyard anchorage as of January 1, 1998 (JLG Industries, 2001). As with boom-supported lifts, however, personal fall arrest systems would not be recommended if the arresting force of the fall could tip over the scissor lift. A restraint system with the anchor in the center of the platform is recommended.

Tipovers of scissor lifts mostly occur while the platform is extended over 15 feet, and especially while driving with the platform extended. Today, the most popular scissor lifts are narrow (46 inches wide) and can reach 20 or 26 feet (Grubenau, 1999). There are scissor lifts available that can reach 50 feet. At such heights, the stability of the lift is of great concern. The popularity of rollout platform extensions also raises stability questions. Pulling or pushing work activities while elevated to such heights can exert horizontal forces that the scissor lift is not designed to withstand. Scissor lifts should not be used for these type of activities, unless the lift can be tied off to a stable anchorage.

Safety features that can be found on some scissor lifts include pothole guards, motion alarms, and tilt alarms. Another possible safety feature would be a motor interlock that would prevent the scissor lift from being driven while extended, except at a crawl speed for slight position adjustments. As with boom-supported lifts, research is needed to examine the stability of scissor lifts under actual use conditions. Again, training in the operational characteristics of the particular scissor lift being used is essential.

4.3. Suspended scaffolds

Deaths from falls and collapses resulting in falls from suspended scaffolds totaled 84 (about 10 per year), and comprised 18% of all such scaffold deaths for 1992–1999. The 1974–1978 OSHA study found that there were 27 fatal suspended scaffold falls—about 5 deaths per year, which comprised 30% of all scaffold falls deaths in that period. As discussed above, the OSHA death counts are incomplete. However, it can be concluded that deaths from suspended

scaffolds do not appear to have decreased appreciably in the past 20 years.

The CFOI data presented here show the main cause of falls from suspended scaffolds to be collapses involving failure of one or more components of the scaffold system. Collapses also involve the possibilities of multiple-fatality incidents, as shown by the data in this study (41 incidents involving 47 deaths).

Suspended scaffolds consist of a platform, rigging to suspend the platform, a hoist to move it up and down, and an anchor for the suspension ropes. The high percentages of collapses due to breaking of suspension ropes (40%) in particular show the need to prevent ropes from breaking. Possible causes of breaking ropes include use of damaged ropes (burns, chemical damage), not protecting them from sharp edges and abrasion, and exceeding the capacity of the ropes. NIOSH FACE reports have implicated rope burns from sources such as welding in several instances (NIOSH, 2000). Given the high percentage of ropes breaking as a cause of collapses of suspended scaffolds, further research is needed to determine if existing standards are adequate.

Tipping of or moving the suspended scaffold caused one-quarter of the falls where a scaffold collapse was not involved; for two-fifths of these falls, the cause was unknown. Wearing of personal fall protection equipment could have prevented these deaths and most of the deaths involving collapse of the scaffold. Inadequate or improperly attached fall protection equipment, including breaking of safety harnesses, lanyards, and lifelines, and attaching lanyards to the scaffold, caused seven deaths (8%). Proper inspection before use and proper training could have prevented these deaths.

Construction and maintenance painters had by far the most deaths, one-third of the total. They accounted for most of the deaths involving suspended scaffolds attached to water towers, grain silos, and bridges. Painters should be targeted for training interventions.

4.4. Other personnel lifts

Crane platform deaths, like those of suspended scaffolds, often involve multiple deaths from the same incident. One recent example was the 1999 deaths of three ironworkers in Milwaukee when the crane platform they were on was struck by another collapsing crane (Crane collapse kills 3, 1999). The lower number of crane platform deaths found in this study—about two per year—are probably due to the fact that crane platforms are not as common as other types of personnel lifts. OSHA allows the use of crane platforms as personnel lifts only if other methods of access are not feasible or are more hazardous (29 CFR 1926.550 (g)). Crane platforms could find increased use as a work platform, rather than just for raising and lowering personnel, at heights where other types of personnel lifts are not feasible. This could be particularly useful for certain stages of structural steel erection where unstable structures make it dangerous for workers to work from the structure. Training of crane operators in the operation of crane platforms is essential.

Falling off the forks or unsecured platforms on forklifts was the major cause of death reported here. OSHA only allows forklifts to be used to lift workers if the scaffold platform is attached to the fork and the forklift is not moved horizontally while the platform is occupied (29 CFR 1926.451(c)(2)(v)). The forklift must be specifically designed by the manufacturer for that purpose or be certified by a certified professional engineer that the equipment was designed for that purpose (Swanson, 1999). Similarly, front-end loaders and similar pieces of equipment cannot be used to support scaffold platforms unless designed for that purpose (29 CFR 1926.451(c)(2)(iv)). Following the above OSHA regulations is the best way to eliminate these deaths from unapproved lifts.

5. Summary

Personnel lifts, especially aerial lifts, are increasingly becoming popular in construction, causing about 42 deaths per year—3.5% to 4% of all construction deaths. Analysis of CFOI records for 1992–1999 show that the major causes of deaths for construction workers due to personnel lifts are falls, collapses/tipovers, and electrocutions. General recommendations to decrease the number of deaths include: following OSHA regulations, wearing of personal fall protection equipment, adequate maintenance of personnel lifts, inspection before use, and training in the use of the particular model of personnel lifts being used.

For boom-supported lifts, contact with overhead power lines was the major cause of death. Electrical workers should de-energize or insulate the power line; if this is not possible, adequate personal protective equipment and insulated tools should be used. The bucket should be insulated. Non-electrical workers should keep at least 10 feet away from overhead power lines. Other precautions for boom-supported lifts include controlling the bucket movement and setting up traffic barriers to avoid being struck by vehicles.

For vertical lifts such as scissor lifts, guardrails and chains should be present and fastened, and a personal fall restraint system used. The lift should not be driven with the platform elevated. Work activities should be examined to see if they exert excessive horizontal forces on the vertical lift, which could cause it to tip over.

For suspended scaffolds, special recommendations include: protecting suspension ropes and vertical lifelines, ensuring proper design and construction of suspended scaffolds, and providing adequate anchorages for vertical lifelines and scaffold tiebacks.

Forklifts should only be used to support scaffold platforms if they are designed by the manufacturer for that use.

The forklift should not be moved while the platform is occupied.

Research is needed on the stability of aerial lifts under actual use conditions. In addition, research is needed on the adequacy of standards for ropes for suspended scaffolds.

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