

AN ANALYSIS OF FATAL EVENTS IN THE CONSTRUCTION INDUSTRY 2008

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This report is based upon OSHA-inspected fatal events in construction during calendar 2008. The data analyzed were provided by Dave Schmidt, Director, Office of Statistical Analysis, Occupational Safety and Health Administration. William R. Schriver, Ph.D., Director; Thomas E. Cressler II, M.S., Senior Associate Director and John Wagner, M. S., Research Associate II conducted the study and prepared this report. This research was supported by contract No. J9F20016 with the United States Department of Labor, Occupational Safety and Health Administration. The authors are solely responsible for all interpretations, conclusions and any errors found in the report.

Executive Summary

Occupational Safety and Health Administration (OSHA) inspected 594 fatal construction incidents (excluding non-work related causes), involving 630 fatalities, in calendar year 2008. Seven of the 30 proximal causes classified in this report accounted for 296 (49.8 percent) of the fatal events investigated. They were: (1) *Falls from/through Roofs*: 66 events (11.1 percent); (2) *Falls from/with Structures*: 52 events (8.8 percent); (3) *Crushed/run-over of Non-Operator of Construction Equipment*: 45 events (7.6 percent); (4) *Crushed/run-over/trapped of Operator of Construction Equipment*: 37 events (6.2 percent); (5) *Fall from/with scaffold*: 34 events (5.7 percent); (6) *Hit, crushed, fall during lifting operations*: 31 events (5.2 percent) and (7) *Fall from/with ladder*: 31 events (5.2 percent).

A comparison of the year-to-year ranks of the proximal causes during the 1991-2008 period shows that they are highly and significantly correlated, i.e., the individual ranks of the causes vary little from year-to-year.

Most of the fatal events involved a single victim, but 25 (4.2 percent) of the events were multi-fatality events which accounted for 61 (9.7 percent) of the fatalities.

Other findings were: (1) *Initiation*. In 336 (56.6 percent) of the fatal events the victim was judged to be the primary initiator of the cause; in 170 events (28.6 percent) the victim was judged to be simply in the wrong place at the wrong time; in 56 events (9.4 percent) another employee was judged to be the primary initiator of the cause; 21 events (3.5 percent) could not be classified; and in 11 events (1.8 percent) the victim and another employee were judged to be primary initiator of the cause; (2) *Task*. In 571 of the events (96.1 percent) the victim was judged to be performing work at the task site when injured; in 21 events (3.5 percent) the victim was going to or from work or not working when injured; and in 2 events (0.3 percent) no

classification was possible; and (3) Timing. Most fatal events happened on Tuesday with 122 events (20.5 percent) occurring that day of the week, followed by Monday with 120 events (20.2 percent) occurring that day; and most fatal events happened between the 13 and 14 hours (1:00 pm and 2:00 pm) with 66 events (11.1 percent) occurring during this time interval, followed by 10 and 11 hours (10:00 am and 11:00 am) with 63 events (10.6 percent) occurring during this time interval.

A special study examined the causes of fatalities occurring during highway/road construction, undertaken because of its unique exposure to external hazards, vehicular traffic, found that the leading cause of these 70 fatal events was “crushed/run-over by highway vehicle” accounting for 24 events (34.3 percent). The leading contributing cause of these 24 events was highway vehicles losing control and swerving into highway/road work sites, striking workers accounting for 7 of the 24 events (29.2 percent).

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I. Introduction

This paper reports on the direct causes of fatal events in the construction industry which occurred in calendar year 2008. Fifteen earlier studies¹ by the Construction Industry Research and Policy Center (CIRPC) analyzed the causes of fatal events in this industry in 1991-1992, 1993-1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006 and 2007.

II. Data

The data analyzed in this report, provided by OSHA from Form 170's, consist of narrative descriptions of the 594 fatal events inspected by OSHA resulting from accidents which occurred in construction during calendar year 2008. In this report, as in earlier reports, analysis includes all OSHA-inspected fatal construction events regardless of Federal or State administration.

The Occupational Safety and Health Act of 1970 provides States with the option of administering the Act themselves or accepting Federal administration of the Act. Twenty-nine States and the District of Columbia chose administration under the Federal System, and the remaining 21 States and two Territories chose self-administration under State Plans².

As in the earlier studies, non-accidental fatalities on construction sites or contractor yards (such as deaths from non-work related heart attacks, strokes, seizures, etc.) and fatalities of

¹ An Analysis of Fatal Events in the Construction Industry, 1991-1992 (1993), An Analysis of Fatal Events in the Construction Industry, 1993-1994 (1995), An Analysis of Fatal Events in the Construction Industry, 1995 (1996), An Analysis of Fatal Events in the Construction Industry, 1996 (1997), An Analysis of Fatal Events in the Construction Industry, 1997 (1999), An Analysis of Fatal Events in the Construction Industry, 1998 (2000), An Analysis of Fatal Events in the Construction Industry, 1999 (2001), An Analysis of Fatal Events in the Construction Industry, 2000 (2002), An Analysis of Fatal Events in the Construction Industry, 2001 (2003), An Analysis of Fatal Events in the Construction Industry, 2002 (2004), An Analysis of Fatal Events in the Construction Industry, 2003, (2005), An Analysis of Fatal Events in the Construction Industry, 2004 (2006), An Analysis of Fatal Events in the Construction Industry, 2005 (2007), An Analysis of Fatal Events in the Construction Industry, 2006 (2008) and An Analysis of Fatal Events in the Construction Industry, 2007 (2009). Construction Industry Research and Policy Center, University of Tennessee, Knoxville.

² States in the Federal System are: AL, AR, CO, CT, DE, DC, FL, GA, ID, IL, KS, LA, ME, MA, MS, MO, MT, NE, NH, NJ, NY, ND, OH, OK, PA, RI, SD, TX, VI, WV and WI. States and Territories under State Plans are: AK, AZ, CA, HI, IN, IA, KY, MD, MI, MN, NV, NM, NC, OR, PR, SC, TN, UT, VT, VA, WA and WY.

construction workers killed off-site in traffic accidents were excluded from the analysis; in 1991-2007 these fatalities accounted for about 3.6 percent of OSHA-inspected fatal construction but about 5.4 percent in 2008. Although the Occupational Safety and Health Act of 1970 requires employers to report fatalities to OSHA within eight hours of the occurrence of the event, all fatalities on construction sites are not inspected by OSHA; for example, OSHA does not inspect fatal construction events involving independent contractors with no employees. Therefore, the results reported upon here do not provide a year-to-year analysis of changes in the absolute number of fatal events or individuals killed on construction sites.

Each narrative record typically consists of a brief description of the event leading to the fatality, although this is not always the case. Where the narrative description was omitted, inconclusive or completely unclear the event cause was coded “unknown cause or other”; otherwise each narrative was analyzed and classified into one of 31 cause categories, although a great deal of collective judgment was often required to classify the cause of many of the accidents.

CIRPC’s review of over 1200 case files of fatal construction events occurring in 1997, 1998 and 1999 revealed that coded data for an event sometimes did not comport with corresponding narrative descriptions and the narrative descriptions were sometimes internally inconsistent. Later reviews of fatality files for other special studies lead us to believe these inconsistencies continue although at a lower rate. Consequently, the data analyzed in this report are restricted to the direct causes of the fatal events where the authors were able, in most cases, to classify the events with relative certainty according to 31 types of causes. Essentially the same types as were used in CIRPC’s previous fatality studies. For those who are interested, the original coded data from the files are included in Appendix C for the following classifications:

(1) end-use of structure; (2) type of construction; (3) occupation of the victim(s); (4) contract value of the construction project; and (5) construction operation associated with the fatality.

In classifying the events a rule of primacy was followed for multiple-cause fatalities the first cause in the chain of causes was recorded as the cause of the fatal event. Definitions of the causes are shown in Appendix A.

III. Analysis of Fatal Events by Cause

A. Distribution of Fatal Events by Cause

Table 1 shows the cause classification system, the number of times each cause represented a fatal event in 2008, the relative frequency of each cause and the number of victims killed.³ It can be seen that “fall from/through roof” led all other causes in number of fatal events (66 or 11.1 percent of total fatal events), followed by “falls from/with structure (other than roof)” (52 or 8.8 percent). The third leading cause was “crushed/run-over of non-operator by operating construction equipment” (45 or 7.6 percent); the fourth leading cause was “crushed/run-over/trapped of operator of construction equipment” (37 or 6.2 percent); the fifth leading cause was “fall from/with scaffold” (34 or 5.7 percent); the sixth leading cause was “hit, crushed, fall during lifting operations (31 or 5.2 percent); and the seventh leading cause was “fall from/with ladder” (31 or 5.2 percent). The number and relative frequencies of the remaining causes of the 594 fatal events analyzed may be read directly from Table 1. (Comparative frequencies for earlier years are shown in Figures B1 through B4 in Appendix B.)

³ Each event included at least one person killed and in several events additional workers were killed or injured.

Table 1. Construction Fatality Event Causes, 2008

| Event Causes | Description | Number of Events and Victims | | Percent of Events |
|--------------|--|------------------------------|----------------|-------------------|
| | | Events | Victims | |
| 1. | asphyxiation/inhalation of toxic vapor | 5 | 6 | 0.8 |
| 2. | caught in/struck by stationary equipment | 3 | 3 | 0.5 |
| 3. | crushed from collapse of structure | 29 | 31 | 4.9 |
| 4. | crushed/run-over of non-operator by operating construction equipment | 45 | 45 | 7.6 |
| 5. | crushed/run-over/trapped of operator by operating construction equipment | 37 | 37 | 6.2 |
| 6. | crushed/run-over by construction equipment during maintenance/modification | 20 | 29 | 3.4 |
| 7. | crushed/run-over by highway vehicle | 24 | 27 | 4.0 |
| 8. | drown, non-lethal fall | 6 | 8 | 1.0 |
| 9. | electric shock by touching exposed wire | 11 | 11 | 1.9 |
| 10. | electric shock by equipment contacting power source | 30 | 35 | 5.1 |
| | | <u>Event</u> | <u>Percent</u> | |
| a. | ladder | 4 | 0.7 | |
| b. | scaffold | 5 | 0.8 | |
| c. | crane/lifting equipment/boom/dump truck | 11 | 1.9 | |
| d. | contact while handling materials such as gutters, iron rods, etc. | 10 | 1.7 | |
| 11. | electric shock from equipment installation/tool use | 30 | 30 | 5.1 |
| 12. | electric shock, other | 2 | 2 | 0.3 |
| 13. | elevator (struck/crushed by elevator or counter weights) | 2 | 2 | 0.3 |
| 14. | fall from/with ladder: includes collapse/fall of ladder | 31 | 31 | 5.2 |
| 15. | fall from/through roof | 66 | 66 | 11.1 |
| | | <u>Event</u> | <u>Percent</u> | |
| a. | fall off of roof | 38 | 6.4 | |
| b. | fall through roof other than skylight | 14 | 2.4 | |
| c. | fall through skylight or other opening | 14 | 2.4 | |
| 16. | fall from highway vehicle/construction equipment | 1 | 1 | 0.2 |
| 17. | fall from/with scaffold | 34 | 34 | 5.7 |
| 18. | fall from/with bucket (aerial lift/basket) | 17 | 18 | 2.9 |
| 19. | fall from/with structure (other than roof) | 52 | 52 | 8.8 |
| | | <u>Event</u> | <u>Percent</u> | |
| a. | fall with collapse of structure | 17 | 2.9 | |
| 20. | fall from/with platform or catwalk | 14 | 17 | 2.4 |
| 21. | fall through opening (other than roof) | 19 | 19 | 3.2 |

| | | | | |
|-----|--|----|----|-----|
| 22. | fall, other or unknown | 10 | 10 | 1.7 |
| 23. | fire/explosion/scalding | 10 | 12 | 1.7 |
| 24. | hyperthermia/hypothermia | 3 | 3 | 0.5 |
| 25. | hit, crushed, fall during lifting operations | 31 | 32 | 5.2 |
| 26. | struck by falling object/projectile (including tip-over) | 28 | 28 | 4.7 |
| 27. | crushed/suffocation from trench collapse | 18 | 25 | 3.0 |
| 28. | crushed while unloading-loading equipment/material (except by crane) | 6 | 6 | 1.0 |
| 29. | shock/burn from lightning | 0 | 0 | 0.0 |
| 30. | crushed other | 3 | 3 | 0.5 |
| 31. | unknown cause or other | 7 | 7 | 1.2 |

| | | <u>Event</u> | <u>Percent</u> |
|----|-------|--------------|----------------|
| a. | Other | 3 | 0.5 |

| | | | | |
|--------------|--|------------|------------|--------------|
| Total | | <u>594</u> | <u>630</u> | <u>100.0</u> |
|--------------|--|------------|------------|--------------|

At the risk of misleading the reader by over generalizing, it may be informative to describe examples of frequently occurring specific situations leading to the 7 most frequent causes of fatal events listed in Table 1.

Falls from /with/through Roofs. An inattentive roofer or laborer without fall protection walks backward and off the roof or steps into a skylight opening or onto a covered skylight opening.

Falls from/with Structures. An ironworker without fall protection slips or loses balance while erecting steel frame and falls or a carpenter or an ironworker falls as a result of a collapsing structure or structural component.

Crushed, Run-over, Non-operator. A laborer guiding trucks while backing up, a grade checker or a laborer performing site clean-up in proximity of excavating machinery is run-over after getting out of the line-of-sight of an operator/driver.

Crushed/Run-over...Operator. Mobile construction equipment, such as a dozer or fork lift, goes over an embankment and rolls over or turns over when encountering uneven terrain, resulting in the crushing of the operator. (The operator may be crushed inside the equipment or crushed by the equipment while trying to escape.)

Fall from/with scaffold. A worker moving on a scaffold missteps or steps on a loose plank and falls from the scaffold. Workers also fall from scaffolds during entry/exit and fall from/ with scaffolds during assembly/disassemble.

Hit, crushed, fall during lifting operations. A rigger or laborer is struck by a crane load or lifting equipment or a worker falls while riding a suspended load of a crane.

Fall from/with Ladder. Worker falls from or with a ladder because he/she overreaches or fails to secure the ladder or missteps or slips or simply loses balance.

The number of victims killed by each cause is also shown in Table 1 where it can be seen that in most events only one worker was killed per event. There were 19 fatality causes where no event had multiple fatalities; only 11 fatality causes included events with multiple fatalities. “Crushed/run-over by construction equipment during maintenance/modification” was the fatality

cause which had the most victims killed per event, i.e., 20 events and 29 victims or 1.45 victims per event.

The data for construction fatalities in 2008 show that 25 of the fatal events, 4.2 percent of fatal events, involved multiple fatalities. The multiple-fatality events averaged 2.4 fatalities per event and accounted for 61 fatalities, 9.7 percent of the 630 fatalities. The multiple-fatality events accounted for an additional 36 fatalities, 5.7 percent of the 630 individuals killed in 2008.

These results parallel those reported by the Bureau of Labor Statistics (BLS). During 1995-1999, 4 percent of all fatal work-related events involved multiple fatalities, and these multiple-fatality events accounted for 10 percent of the workers killed during the period. They averaged three fatalities per incident.⁴ It should be noted that the BLS data included homicides, and they accounted for 19 percent of their multi-fatality incidents. There were no homicides in the 2008 OSHA data. If homicides had been reported they would have been excluded from the analysis as they have been in prior years.

Table 2 shows a comparison of the ranks of the causes in 2008 with the average rank of the causes of fatal events during the period 1991 - 2007. It can be seen that the overall rank pattern of the causes in 2008 is very similar to the rank pattern in 1991 – 2007. An overall statistical comparison of the correlation of the rank in 2008 with the average rank in 1991-2007 was calculated using a Spearman rank correlation procedure.⁵ The correlation obtained was + .92, $p < .001$, indicating that the ranks of the causes in the two time periods are highly and

⁴ Drudi, Dino and Mark Zak, "Work-Related Multi-Fatality Incidents," *Monthly Labor Review*, Vol. 127, No. 10, October 2004.

⁵ Sidney Siegel, *Nonparametric Statistics for the Behavioral Sciences* (New York: McGraw-Hill Book Co., Inc., 1956), p. 219.

positively correlated, i.e., did not change significantly between 1991 – 2007 and 2008⁶. The Spearman rank-order correlation between 2007 and 2008 causes was calculated and found to be + .94, $p < .001$, indicating also that the pattern changed very little between 2007 and 2008.

The correlation result is not surprising given that the general composition of construction output, and therefore the mix of construction operations required to produce the output, was probably very similar during the time periods examined. This interpretation implies that the rank of a cause is a function of the magnitude of exposure to the cause and/or the inherent danger associated with the cause.

The rank order of fatality causes has not changed significantly while falls have become relatively more important. Falls, as a whole, now represent 41.2 per cent of construction fatalities. For the 1991-2007 period they represented 36.5 per cent of construction fatalities.

⁶Five of the 719 fatal events in 2002 and 17 of 719 fatal events in 2001 had either no narrative or a narrative too incomplete to classify the cause of fatality. These records were coded as “unknown” cause; this was not done in prior years. They were omitted from the calculation of the Spearman Rank correlation in order to avoid data distortion.

Table 2. Comparison of Ranks of Causes of Fatal Events in 1991 - 2007 with 2008

| <u>Event</u> | <u>1991 - 2007 Average</u> | | | <u>2008</u> | | |
|---|----------------------------|----------------|-------------|---------------|----------------|-------------|
| | <u>Number</u> | <u>Percent</u> | <u>Rank</u> | <u>Number</u> | <u>Percent</u> | <u>Rank</u> |
| 1. asphyxiation/inhalation of toxic vapor | 8.8 | 1.3 | 22 | 5 | 0.8 | 24 |
| 2. caught in/struck by stationary equipment | 6.3 | 0.9 | 23 | 3 | 0.5 | 25 |
| 3. crushed from collapse of structure | 27.2 | 4.1 | 10 | 29 | 4.9 | 10 |
| 4. crushed/run-over of non-operator by operating construction equipment | 52.4 | 7.9 | 3 | 45 | 7.6 | 3 |
| 5. crushed/run-over/trapped of operator by operating construction equipment | 36.4 | 5.5 | 5 | 37 | 6.2 | 4 |
| 6. crushed/run-over by construction equipment during maintenance/modification | 12.8 | 1.9 | 21 | 20 | 3.4 | 13 |
| 7. crushed/run-over by highway vehicle | 25.9 | 3.9 | 12 | 24 | 4.0 | 12 |
| 8. drown, non-lethal fall | 5.6 | 0.9 | 24 | 6 | 1.0 | 22 |
| 9. electric shock by touching exposed wire | 22.3 | 3.4 | 14 | 11 | 1.9 | 18 |
| 10. electric shock by equipment contacting power source | 43.0 | 6.5 | 4 | 30 | 5.1 | 8 |
| 11. electric shock from equipment installation/tool use | 35.5 | 5.3 | 6 | 30 | 5.1 | 8 |
| 12. electric shock, other | 3.4 | 0.5 | 28 | 2 | 0.3 | 27 |
| 13. elevator (struck/crushed by elevator or counter weights) | 2.9 | 0.4 | 29 | 2 | 0.3 | 27 |
| 14. fall from/with ladder: includes collapse/fall of ladder | 27.0 | 4.1 | 11 | 31 | 5.2 | 6 |
| 15. fall from/through roof | 77.8 | 11.7 | 1 | 66 | 11.1 | 1 |
| 16. fall from highway vehicle/construction equipment | 5.4 | 0.8 | 25 | 1 | 0.2 | 29 |
| 17. fall from/with scaffold | 23.5 | 3.5 | 13 | 34 | 5.7 | 5 |
| 18. fall from/with bucket (aerial lift/basket) | 13.8 | 2.1 | 18 | 17 | 2.9 | 16 |
| 19. fall from/with structure (other than roof) | 56.6 | 8.5 | 2 | 52 | 8.8 | 2 |

Table 2. Comparison of Ranks of Causes of Fatal Events in 1991 - 2007 with 2008 (continued)

| <u>Event</u> | <u>1991 - 2007 Average</u> | | | <u>2008</u> | | |
|---|----------------------------|----------------|-------------|---------------|----------------|-------------|
| | <u>Number</u> | <u>Percent</u> | <u>Rank</u> | <u>Number</u> | <u>Percent</u> | <u>Rank</u> |
| 20. fall from/with platform or catwalk | 15.9 | 2.4 | 16 | 14 | 2.4 | 17 |
| 21. fall through opening (other than roof) | 17.3 | 2.6 | 15 | 19 | 3.2 | 14 |
| 22. fall, other or unknown | 5.4 | 0.8 | 25 | 10 | 1.7 | 20 |
| 23. fire/explosion/scalding | 13.5 | 2.0 | 20 | 10 | 1.7 | 20 |
| 24. hyperthermia/hypothermia | 4.9 | 0.7 | 27 | 3 | 0.5 | 25 |
| 25. hit, crushed, fall during lifting operations | 33.9 | 5.1 | 7 | 31 | 5.2 | 6 |
| 26. struck by falling object/projectile (including tip-over) | 28.5 | 4.3 | 9 | 28 | 4.7 | 11 |
| 27. crushed/suffocation from trench collapse | 29.8 | 4.5 | 8 | 18 | 3.0 | 15 |
| 28. crushed while unloading-loading equipment/material (except by crane) | 13.7 | 2.1 | 19 | 6 | 1.0 | 22 |
| 29. shock/burn from lightning, other | 14.2 | 2.1 | 17 | 10 | 1.7 | 20 |
| TOTAL | <u>663.8</u> | <u>100.0</u> | | <u>594</u> | <u>100.0</u> | |

The number of OSHA-inspected fatal construction events has varied over the years since 1991 as has employment in construction establishments.⁷ The trend of these fatal events per 100,000 construction establishment employees is as follows: 1991 – 1992: 13.1; 1993 – 1994: 11.8; 1995: 11.4; 1996: 10.5; 1997: 10.6; 1998: 10.4; 1999: 11.0; 2000: 9.5; 2001: 10.8; 2002: 10.7; 2003: 10.5; 2004: 11.4; 2005: 10.3; 2006: 10.1; 2007: 9.4 and 2008: 8.3. The trend shows a marked reduction in the number of fatal events per 100,000 construction establishment employees.

IV. Analysis by Victim’s Situation

Fatal events were analyzed to determine the role of the ‘victim’ in each event. The analysis classified the role of the victim by four general categories: (1) victim(s) was (were) primary, immediate contributor to the event; (2) person(s) other than victim(s) was (were) primary, immediate contributor to the event; (3) no individual directly contributed to the event, the victim(s) being “at the wrong place at the wrong time”; and (4) unknown.

The first category includes, for example, most falls, crushed/run-over of operators, electrocutions other than those occurring during lifting operations, asphyxiations and hypothermia. The second category includes, for example, most crushed/run-over of nonoperators, lifting operations, loading/unloading of equipment/materials, struck by highway vehicles, falls from/with aerial lifts, and electrocutions from crane boom/tackle contacting overhead power lines. The third category includes, for example, most structure and trench collapses, struck by projectile/falling objects, and lightning.

⁷ Bureau of Labor Statistics, National Employment, Hours, and Earnings, CES, Table B-1 <http://www.bls.gov/data/>

Although the classifications were often subjective due to a lack of precise information or conflicting information, following are the results for the 594 events: (1) victim primary initiator of event: 336 events (56.6) percent; (2) victim and another employee primary initiator: 11 events (1.8 percent); (3) person other than victim primary initiator: 56 events (9.4 percent); (4) “wrong place at wrong time”: 170 events (28.6 percent); and (5) unknown: 21 events (3.5 percent).

An additional classification of the 594 fatal events was also performed to estimate the distribution of events by work status of the victim. As with the previously discussed classification of who initiated the event, the work status classifications were also subjective. Nevertheless, it may be useful in understanding, in a general sense, the situations in which construction fatalities occur. It was found that: (1) 571 (96.1 percent) of the fatal events involved workers performing work at their task site; (2) 21 (3.5 percent) of the events involved workers going to or from work or not working; and (3) 2 (0.3 percent) of the events could not be classified.

The first category includes, for example, many roofing fatalities, fatalities resulting from structure and trench collapses, events involving crushed/run-over of operators, electrocutions while installing electrical equipment, workers caught in stationary equipment, workers falling from/with aerial lifts and scaffolds and workers climbing/relocating on structures.

V. Analysis of Fatal Events by Day of Week and Time

The fatality data reported on OSHA Form 170 includes the date and time of day of most fatal events. Table 3 shows the distribution of fatal events by day of the week. Contrary to the popular conception that most fatalities occur on Mondays and Fridays, it can be seen that Tuesday had the largest number of events, 122, followed by Monday and Thursday with 120 and 101 events respectively, and Wednesday had the fewest number of week day fatal events, 91.

The number of Monday and Tuesday fatal events is about the same and this is also true for Thursday and Friday. However, without knowing the total number of construction hours worked each day, it is not possible to conclude that any one day is more or less hazardous than another.

Table 3. Distribution of Fatal Construction Events by Day of Week, 2008

| <u>Day</u> | <u>Number of Events</u> | <u>Percent</u> |
|--------------|-------------------------|----------------|
| Monday | 120 | 20.2 |
| Tuesday | 122 | 20.5 |
| Wednesday | 91 | 15.3 |
| Thursday | 101 | 17.0 |
| Friday | 98 | 16.5 |
| Saturday | 48 | 8.1 |
| Sunday | <u>14</u> | <u>2.4</u> |
| Total | 594 | 100.0 |

Table 4 shows the distribution of fatal events by hour (military) of the day. It can be seen that the 13-14 hour period and the 10-11 hour period contained the most fatal events, 66 and 63, respectively. As pointed out previously, without knowing the total hours worked in construction each hour, it is not possible to calculate hourly event rates. However, it may be reasonably assumed that the total construction hours worked each hour during the 8-12 hour period and the 13-17 hour period are approximately equal. If so, the results showing that 220 of the fatal events occurred in the 8-12 hour period and a nearly equal number, 211, occurred in the 13-17 hour period are not surprising. Nearly three fourths of the fatal events occurred during these two periods.

Table 4. Distribution of Fatal Construction Events by Hour, 2008

| <u>Hour</u> | <u>Number of Events</u> | <u>Percent</u> |
|---------------------|-------------------------|----------------|
| 0-1 | 4 | 0.7 |
| 1-2 | 5 | 0.8 |
| 2-3 | 2 | 0.3 |
| 3-4 | 2 | 0.3 |
| 4-5 | 0 | 0.0 |
| 5-6 | 5 | 0.8 |
| 6-7 | 7 | 1.2 |
| 7-8 | 40 | 6.7 |
| 8-9 | 41 | 6.9 |
| 9-10 | 58 | 9.8 |
| 10-11 | 63 | 10.6 |
| 11-12 | 58 | 9.8 |
| 12-13 | 43 | 7.2 |
| 13-14 | 66 | 11.1 |
| 14-15 | 59 | 9.3 |
| 15-16 | 47 | 7.9 |
| 16-17 | 39 | 6.6 |
| 17-18 | 21 | 3.5 |
| 18-19 | 10 | 1.7 |
| 19-20 | 7 | 1.2 |
| 20-21 | 4 | 0.7 |
| 21-22 | 6 | 1.0 |
| 22-23 | 2 | 0.3 |
| 23-24 | 2 | 0.3 |
| Missing | <u>3</u> | <u>0.5</u> |
| <i>Total</i> | 594 | 100.0 |

VI. Highway/Road Construction Fatalities

One might think that highway/street construction would be relatively safe, since most work activity at these sites occurs at or near ground level. However, in 2008, 74 workers were killed in 70 events while working on highway/street projects. On-site operating construction equipment was involved in 32 fatal events (45.8 percent). Falls from elevations, the leading direct cause of construction fatalities, would have a low potential.

Table 5 ranks the direct causes of the fatal events by their frequency. The table shows that the leading causes were “crushed/run-over by highway vehicle” (24 events or 34.3 percent), followed by “crushed/run-over of nonoperator by operating construction equipment” (23 events or 32.9 percent), and “crushed/run-over of operator by operating construction equipment” (9 events or 12.9 percent). Other event causes are shown in Table 5.

Since traffic on many or most highway/road varies by time of day, and most construction on highway/road occurs during the day, one might expect that most “crushed/run-over by highway vehicles” fatalities would occur during morning and afternoon commuting periods when traffic loads peak. Table 6 shows fatal events caused by victim being struck/run-over by highway vehicles by time of day (1- 24 hours). It can be seen that mid-morning period had the most events, 7 events (29.2 percent), followed by dawn, 4 events (16.7 percent), late-afternoon, evening and late-night, each with 3 events (12.5 percent) and early-morning and mid-day, each with 2 events (8.3 percent).

It is not possible to calculate fatality rates for these time-of-day periods without knowing the hours worked in each period, however, as mentioned earlier the morning and evening commuting periods would seem to be the times when these events are most likely to occur. With shifting road work practices, road work done at night to avoid traffic congestion, the historical

and expected periods of fatal events may be changing. More information about conditions which contribute to fatalities in highway/roadway construction would seem to be an area worthy of further investigation.

Table 5. Frequency of Fatality Causes in Highway/Road Construction, 2008

| | <u>Frequency</u> | <u>Percent %</u> |
|--|------------------|------------------|
| Crushed/run-over by highway vehicle | 24 | 34.3 |
| Crushed/run-over of non-operator by operating construction equipment | 23 | 32.9 |
| Crushed/run-over of operator by operating construction equipment | 9 | 12.9 |
| Crushed/run-over by construction equipment during main/mod. | 4 | 5.7 |
| Hit/crushed/fall during lifting operation | 2 | 2.9 |
| Crushed/suffocation from trench collapse | 2 | 2.9 |
| Drown, non-lethal fall | 1 | 1.4 |
| Electric shock by equipment contacting power source | 1 | 1.4 |
| Fall from highway vehicle/construction equipment | 1 | 1.4 |
| Fall from/with structure | 1 | 1.4 |
| Fall from/with platform or catwalk | 1 | 1.4 |
| Struck by falling object/projectile | 1 | 1.4 |
| Total | 70 | 100.0 |

**Table 6. Construction Fatalities Caused by “Crushed/Run-Over by Highway Vehicle”
by Time of Day, 2008**

| <u>Time</u> | <u>Frequency</u> | <u>Percent (%)</u> |
|-------------------------------|------------------|--------------------|
| Early Morning: 24:00 - 5:00 | 2 | 8.3 |
| Dawn: 5:00 - 8:00 | 4 | 16.7 |
| Mid-Morning: 8:00 - 11:00 | 7 | 29.2 |
| Mid-Day: 11:00 - 14:00 | 2 | 8.3 |
| Late-Afternoon: 14:00 - 17:00 | 3 | 12.5 |
| Evening: 17:00 - 20:00 | 3 | 12.5 |
| Late Night: 20:00 - 24:00 | <u>3</u> | <u>12.5</u> |
| TOTAL | 24 | 100.0 |

Since “crushed/run-over by highway vehicle” was the leading direct cause of fatal events occurring in highway/road construction, it may be helpful in protecting workers engaged in highway/road construction by looking for specific situations in which these fatalities occurred. The often brief summaries of highway construction fatalities in IMIS provided little or no information on speed limits, pavement conditions, visibility, protective barriers, work zone markings or potential impairments of vehicle operators involved in the fatalities. However, it was still possible to identify seven sub-categories of “crushed/run-over by highway vehicle”. Table 7 shows these sub-categories and their frequency.

This table shows that the largest numbers of fatal events occurred when highway vehicles lost control and swerved into work zones striking workers, accounting for 7 (29.2 percent) of the fatal events. This sub-category was followed by the situation where flaggers were struck by highway vehicles passing work zones, representing 4 (16.7 percent) of the events and by the situation where a highway vehicle struck a paving worker in an unprotected work zone, representing 3 (12.5 percent) of the events. Four of the event descriptions (16.7 percent) were

inadequate for classification, indicating only that the worker had been run-over by a highway vehicle.

Table 7. Frequency of Sub-Categories of “Crushed/Run-Over by Highway Vehicle”, 2008

| <u>Sub-Category</u> | <u>Frequency</u> | <u>Percent (%)</u> |
|--|------------------|--------------------|
| 1. highway vehicle lost control and entered (by swerving or inadvertently entering) well-identified work zone, striking victim | 7 | 29.2 |
| 2. highway vehicle struck victim installing signs or traffic signals in unprotected work zone | 2 | 8.3 |
| 3. highway vehicle struck victim (flagger) signaling traffic at beginning of marked work zone. | 4 | 16.7 |
| 4. highway vehicle struck victim working (paving) in unprotected work zone | 3 | 12.5 |
| 5. highway vehicle struck victim who walked into traffic zone | 2 | 8.3 |
| 6. highway vehicle struck shadow vehicle protecting moving vehicle from which victim was performing work, crushing victim | 1 | 4.2 |
| 7. highway vehicle struck victim by entering inadequately marked and protected work zone | 1 | 4.2 |
| 8. unknown | <u>4</u> | <u>16.7</u> |
| TOTAL | 24 | 100.0 |

APPENDIX A

Definitions of Fatality Causes

1. asphyxiation/inhalation of toxic vapor: lack of oxygen and/or inhalation of toxic gas, (excluding asphyxiation resulting from fire/explosion)
2. caught in/struck by stationary equipment: body or clothing caught pulling worker into equipment
3. collapse of structure: building or other structure falling on worker, not including falling ladder, scaffold, aerial lift/ basket, platform, with a structure, trench collapse, or wall (earthen) collapse
4. crushed/run-over of non-operator by operating construction equipment: non-operator run-over or crushed between equipment and ground or another object by an operator controlled piece of construction equipment
5. crushed/run-over/trapped of operator by operating construction equipment: includes rollover and catching of body in equipment or between equipment and ground or other object while operating the equipment*
6. crushed/run-over by construction equipment during maintenance/ modification: includes equipment/parts falling on worker while assembling or disassembling equipment
7. crushed/run-over by highway vehicle: any run-over by non-construction equipment, including trains
8. drown, non-lethal fall: non-lethal falls into water and flooding of container, trenches, etc
9. electrocution by touching exposed wire/source: body part contacting the wire/source except when installing equipment or using a tool
10. electrocution by equipment contacting wire
 - a. ladder
 - b. scaffold
 - c. crane/lifting equipment/boom/dump truck
 - d. other: contact while handling materials, e g. gutters, iron rods, painting equipment, etc.
11. electrocution from equipment installation/tool use: includes failure to de-energize equipment, inappropriate energizing, contacting energized part with tool or body, and inadequately grounded tools or exposed tool wires
12. electric shock, other and unknown cause
13. elevator (struck/crushed by elevator or counter-weights)
14. fall from/with ladder: includes collapse/fall of ladder

*Includes fatalities resulting from asphyxiation/fire/explosion/drowning of trapped operators.

15. fall from roof; fall through roof: skylight or other opening
 - a. fall off of roof
 - b. fall through roof other than skylight
 - c. fall through skylight or other opening
16. fall from vehicle (vehicle/construction equipment): falls from vehicle or equipment while in motion or at rest.
17. fall from/with scaffold: includes collapse/fall of scaffold
18. fall from/with bucket (aerial lift/basket): includes collapse/fall of bucket
19. fall from/with structure (other than roof): fall through opening in the side or through the floor (not opening in the floor) and with the structure in a collapse
 - a. fall with collapse of structure
20. fall from/with platform or catwalk (attached to structure: includes collapse/fall of platform)
21. fall through opening (other than roof): falls through stairwells, equipment openings, or other openings in a floor
22. fall, other or unknown
23. fire/explosion/scalding, excluding electrical burns/explosions
24. heat/hypothermia
25. lifting operations: failure of equipment, inappropriate lifting, and all loading and unloading by crane operations except electrocution. (Includes objects falling and striking victim during lifting operation)
26. struck by falling object/projectile (including tip-over): does not include collapse of structure, trench, earthen wall, or lifting operations
27. trench collapse: includes earthen wall
28. unloading-loading equipment/material (except by crane): includes slipping and tipping over of construction equipment/material while loading and unloading
29. lightning
30. crushed
31. unknown cause or other
 - a. other

APPENDIX B

Figure B1. Comparison of Construction Fatal Events (1995-2007 with 2008)

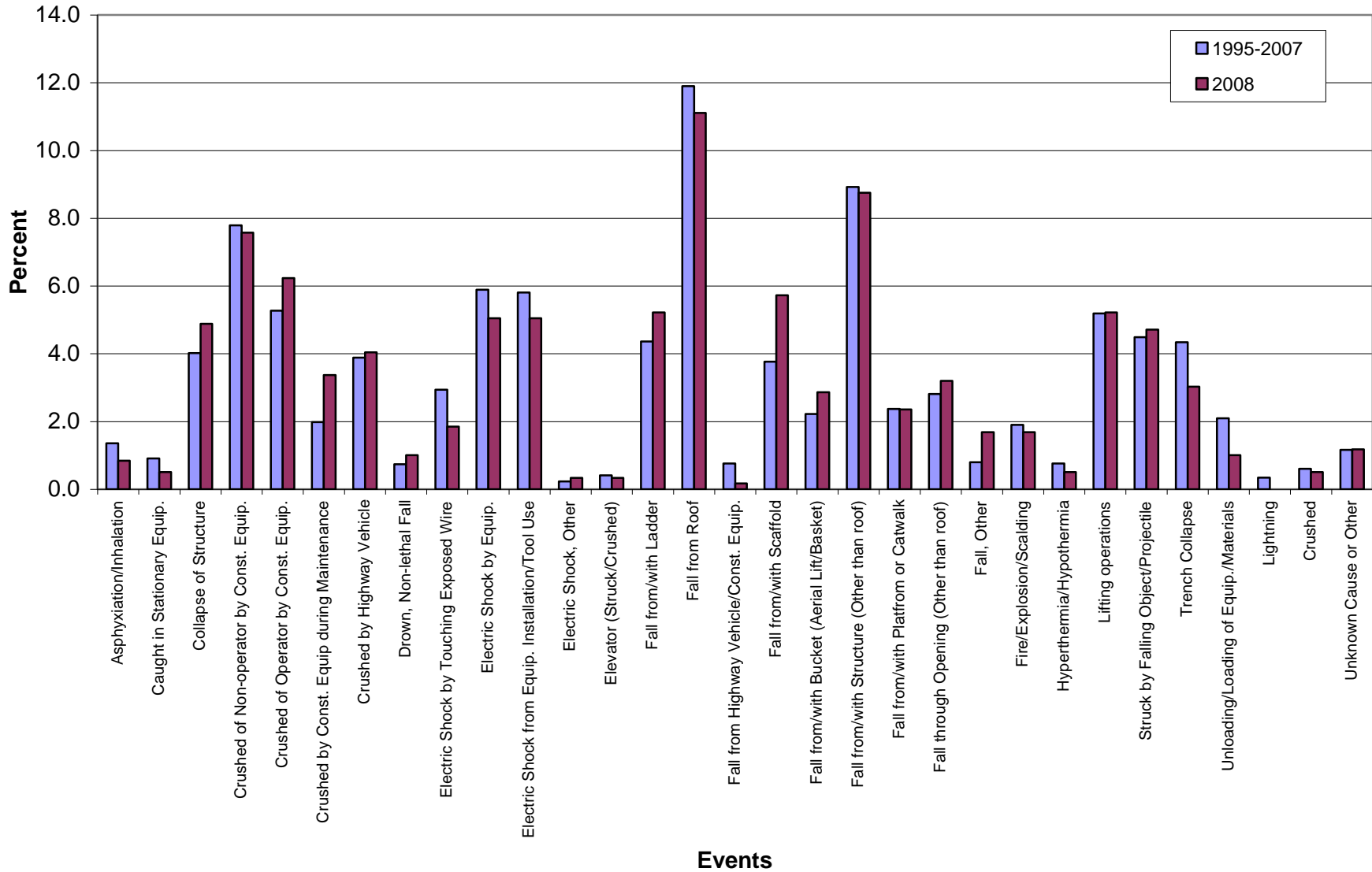


Figure B2. Comparison of Construction Fatal Events (2008)

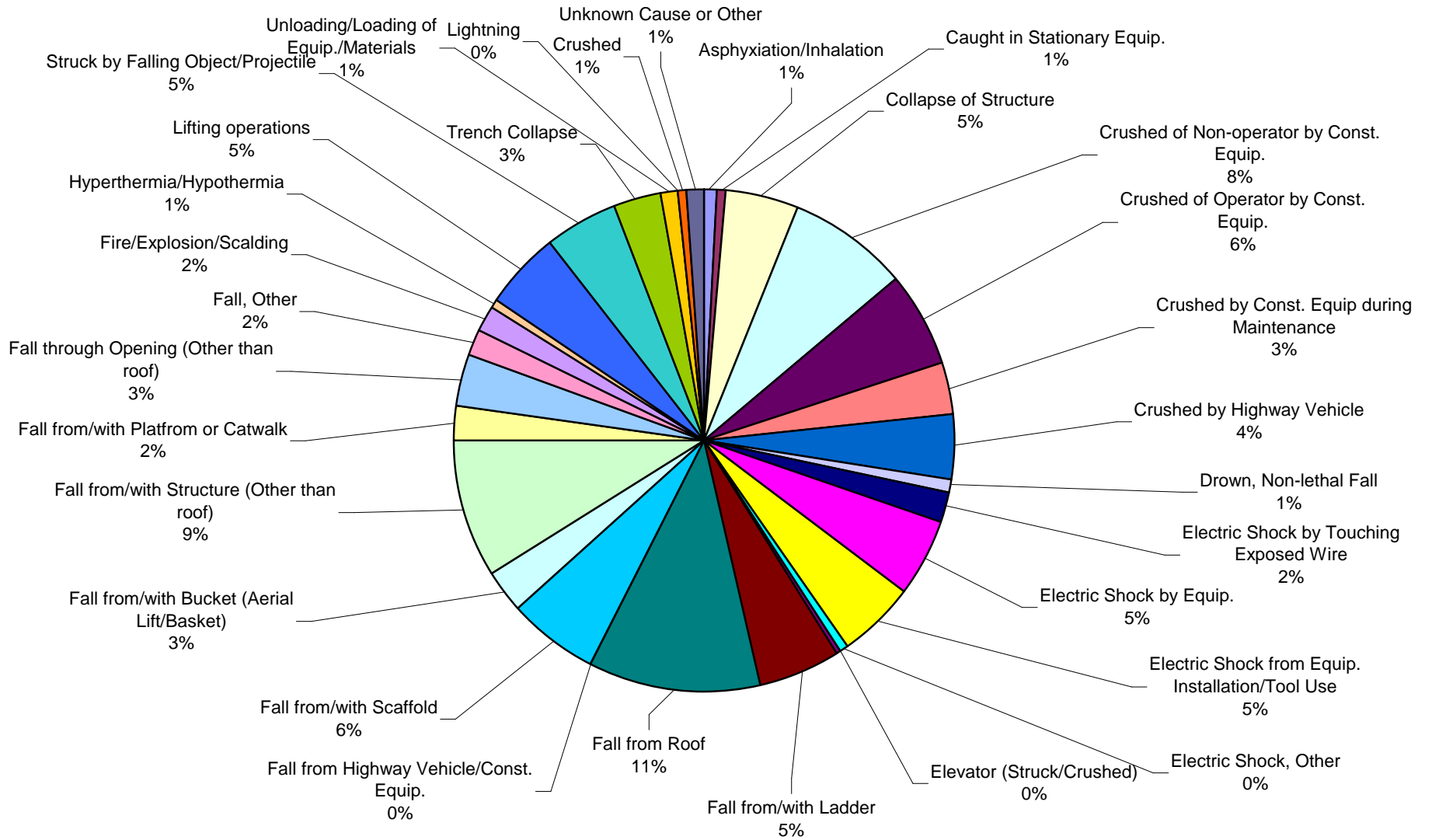
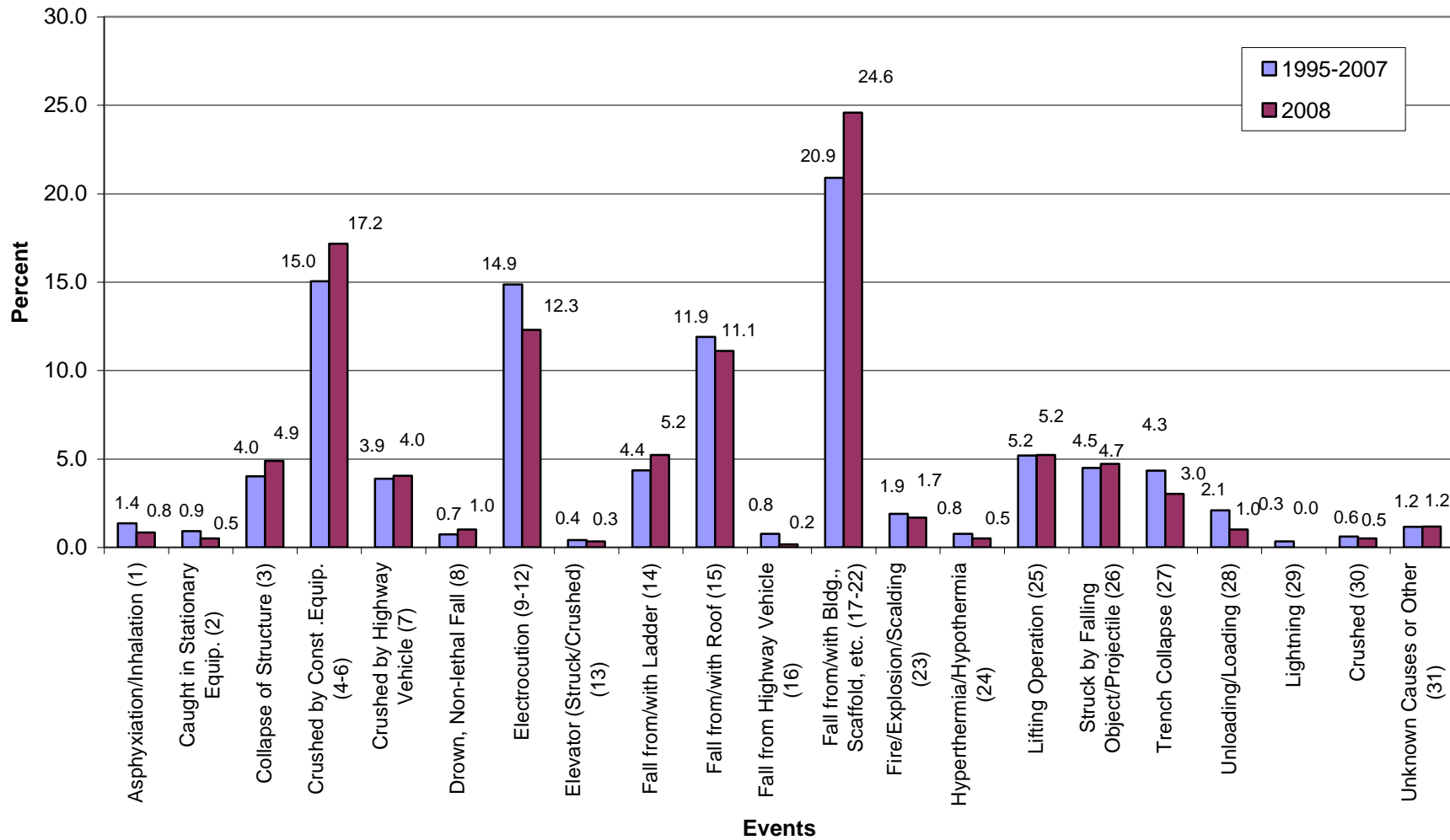


Figure B4. Comparison of Construction Fatal Events (1995-2007 and 2008)



APPENDIX C

Table C1. Construction Fatal Events by End-Use Type, 2008

| End Use Type | Description | Number of Events | Percent |
|-------------------------|---------------------------------------|-----------------------------|----------------|
| 1 | Bridge | 16 | 2.7 |
| 2 | Commercial Building | 137 | 23.1 |
| 3 | Contractor's Yard/Facility | 6 | 1.0 |
| 4 | Excavation, Landfill | 12 | 2.0 |
| 5 | Highway, Road, Street | 60 | 10.1 |
| 6 | Manufacturing Plant | 19 | 3.2 |
| 7 | Multi-Family Dwelling | 57 | 9.6 |
| 8 | Other Building | 85 | 14.3 |
| 9 | Other Heavy Construction | 17 | 2.9 |
| 10 | Pipeline | 15 | 2.5 |
| 11 | Power line, Transmission Line | 18 | 3.0 |
| 12 | Power plant | 14 | 2.4 |
| 13 | Refinery | 6 | 1.0 |
| 14 | Sewer/Water Treatment Plant | 21 | 3.5 |
| 15 | Shoreline Development, Dam, Reservoir | 3 | 0.5 |
| 16 | Single Family or Duplex Dwelling | 88 | 14.8 |
| 17 | Tower, Tank, Storage Elevator | 12 | 2.0 |
| 18 | Missing | <u>8</u> | <u>1.4</u> |
| | | 594 | 100.00 |

Table C2. Construction Fatal Events by Type of Project, 2008

| Project Type | Description | Number of Events | Percent |
|---------------------|---|-------------------------|----------------|
| 1 | New, Addition and Alteration Construction | 403 | 67.8 |
| 2 | Maintenance, Repair and Demolition | 142 | 23.9 |
| 3 | Other | 42 | 7.1 |
| X | Missing | <u>7</u> | <u>1.2</u> |
| | | 594 | 100.0 |

Table C3. Construction Fatal Events by Four-Digit SIC, 2008

| Description | SIC | Number of Events | Percent |
|---|------------|-----------------------------|----------------|
| General Contractors - Single Family Houses | 1521 | 19 | 3.2 |
| General Contractors - Residential Buildings Other than Single Family | 1522 | 14 | 2.4 |
| Operative Builders | 1531 | 4 | 0.7 |
| General Contractors - Industrial Building and Warehouses | 1541 | 12 | 2.0 |
| General Contractors - Non-residential Buildings, other than Industrial and Warehouse | 1542 | 31 | 5.2 |
| Highway and Street Construction, Except Elevated Highways | 1611 | 42 | 7.1 |
| Bridge, Tunnel, and Elevated Highway Construction | 1622 | 18 | 3.0 |
| Water, Sewer, Pipeline, and Communications and Power Line Construction | 1623 | 40 | 6.7 |
| Heavy Construction, Not Elsewhere Classified | 1629 | 25 | 4.2 |
| Plumbing, Heating and Air-Conditioning | 1711 | 31 | 5.2 |
| Painting and Paper Hanging | 1721 | 22 | 3.7 |
| Electrical Work | 1731 | 42 | 7.1 |
| Masonry, Stone Setting, and Other Stone Work | 1741 | 26 | 4.4 |
| Plastering, Drywall, Acoustical, and Insulation Work | 1742 | 17 | 2.9 |
| Terrazzo, Tile, Marble, and Mosaic Work | 1743 | 1 | 0.2 |
| Carpentry Work | 1751 | 23 | 3.9 |
| Floor Laying and Other Floor Work | 1752 | 3 | 0.5 |
| Roofing, Siding, and Sheet Metal Work | 1761 | 57 | 9.6 |
| Concrete Work | 1771 | 24 | 4.0 |
| Water Well Drilling | 1781 | 2 | 0.3 |
| Structural Steel Erection | 1791 | 41 | 6.9 |
| Glass and Glazing Work | 1793 | 5 | 0.8 |
| Excavation Work | 1794 | 19 | 3.2 |
| Wrecking and Demolition Work | 1795 | 16 | 2.7 |
| Installation or Erection of Building Equipment, Not Elsewhere Classified | 1796 | 8 | 1.4 |
| Special Trade Contractors, Not Elsewhere Classified | 1799 | <u>52</u> | <u>8.8</u> |
| | | 594 | 100.0 |

Table C4. Construction Fatal Events by Project Value, 2008

| Project Value Code | Description | Number of Events | Percent | Cumulative Percent |
|---------------------------|--------------------------|-------------------------|----------------|---------------------------|
| 1 | Under \$50,000 | 176 | 29.6 | 29.6 |
| 2 | \$50,000-\$250,000 | 92 | 15.5 | 45.1 |
| 3 | \$250,000-\$500,000 | 52 | 8.8 | 53.9 |
| 4 | \$500,000-\$1,000,000 | 61 | 10.3 | 64.1 |
| 5 | \$1,000,000-\$5,000,000 | 90 | 15.2 | 79.3 |
| 6 | \$5,000,000-\$20,000,000 | 62 | 10.4 | 89.7 |
| 7 | \$20,000,000 and over | 54 | 9.1 | 98.8 |
| 8 | Missing | <u>7</u> | <u>1.2</u> | 100.0 |
| | | 594 | 100.0 | |

Table C5. Construction Fatalities by Construction Operation, 2008

| Code | Description | Number of Fatalities | Percent of Fatalities |
|-------------|---|-----------------------------|------------------------------|
| 01 | Backfilling and compacting | 17 | 2.9 |
| 04 | Cutting concrete pavement | 3 | 0.5 |
| 05 | Demolition | 28 | 4.7 |
| 06 | Dredging | 3 | 0.5 |
| 07 | Elevator, escalator installation | 5 | 0.8 |
| 08 | Emplacing reinforcing steel | 6 | 1.0 |
| 09 | Erecting structural steel | 34 | 5.7 |
| 10 | Erection of coffer dams, caissons | 2 | 0.3 |
| 11 | Excavation | 17 | 2.9 |
| 12 | Exterior masonry | 26 | 4.4 |
| 13 | Exterior cladding | 7 | 1.2 |
| 14 | Exterior carpentry | 21 | 3.5 |
| 15 | Exterior painting | 21 | 3.5 |
| 16 | Fencing, installing lights, signs, etc. | 8 | 1.4 |
| 17 | Fireproofing | 2 | 0.3 |
| 18 | Forming | 6 | 1.0 |
| 19 | Forming for Piers or Pylons | 2 | 0.3 |
| 20 | Installing interior walls, ceilings, doors | 13 | 2.2 |
| 21 | Installing metal siding | 5 | 0.8 |
| 22 | Installing windows and doors, glazing | 10 | 1.7 |
| 23 | Installing culverts and incidental drainage | 5 | 0.8 |
| 24 | Installing equipment (HVAC and other) | 35 | 5.9 |
| 25 | Installing plumbing, lighting fixtures | 18 | 3.0 |
| 26 | Installing underground plumbing conduit | 1 | 0.2 |
| 27 | Interior Tile Work (ceramic, vinyl, acoustic) | 1 | 0.2 |
| 28 | Interior masonry | 7 | 1.2 |
| 29 | Interior plumbing, ducting, electrical work | 13 | 2.2 |
| 30 | Interior carpentry | 9 | 1.5 |
| 31 | Interior painting and decorating | 7 | 1.2 |
| 32 | Landscaping | 3 | 0.5 |
| 34 | Paving | 13 | 2.2 |
| 35 | Pile driving | 1 | 0.2 |
| 36 | Placing bridge deck | 1 | 0.2 |
| 37 | Placing bridge girders and beams | 2 | 0.3 |
| 38 | Plastering | 5 | 0.8 |
| 39 | Pouring or installing floor decks | 6 | 1.0 |
| 40 | Pouring concrete floor at grade | 3 | 0.5 |
| 42 | Pouring concrete foundations and walls | 6 | 1.0 |

Table C5. Construction Fatalities by Construction Operation, 2008 (continued)

| | | | |
|----|---|-----------|------------|
| 43 | Roofing | 51 | 8.6 |
| 44 | Seawall construction, riprap placement | 1 | 0.2 |
| 45 | Site clearing and grubbing | 10 | 1.7 |
| 46 | Site grading and rock removal | 11 | 1.8 |
| 47 | Stripping and curing concrete | 1 | 0.2 |
| 48 | Surveying | 1 | 0.2 |
| 50 | Temporary work (buildings, facilities) | 23 | 3.9 |
| 51 | Traffic protection | 15 | 2.5 |
| 52 | Trenching, installing pipe | 21 | 3.5 |
| 53 | Waterproofing | 4 | 0.7 |
| 54 | Steel Erection of Solid Web-Connecting | 1 | 0.2 |
| 55 | Steel Erection, Solid Web-Bolting, Detail Work | 2 | 0.3 |
| 56 | Steel Erection Of Solid Web-Welding/Burning/Grinding | 1 | 0.2 |
| 59 | Steel Erection, Solid Web-Hoisting | 1 | 0.2 |
| 60 | Steel Erection of Open Web Steel Joists-Connecting | 2 | 0.3 |
| 62 | Steel Erection of Open Web Steel Joists/Welding/Burning/Grinding | 1 | 0.2 |
| 66 | Installation of Decking-Initial Laying Deck (Including Layout & Safety) | 5 | 0.8 |
| 69 | Installation of Decking Hoisting Bundles | 2 | 0.3 |
| 70 | Other Activities-Installing Ornamental and Architectural Steel | 9 | 1.5 |
| 71 | Other Activities-Post Decking Detail Work | 7 | 1.2 |
| 00 | Missing | <u>53</u> | <u>8.9</u> |
| | | 594 | 100.0 |
