

# Causes, Sources and Costs of Falls in a Helicopter Manufacturing Plant

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Slips, trips and falls (STFs) were evaluated among 4,070 workers employed at a large helicopter manufacturing plant from January 1, 2004 to February 28, 2008. The purpose of this evaluation was to estimate rates and determine the leading causes of STFs in the plant and their associated medical costs. Company records on workers' compensation claims, company physician and nurse first report of injury, and payroll records of the number of hours worked were collected on all workers. Cause and source of all injuries and cause of the first initiating event of STFs were coded for analysis. During the study period, there were 2,378 injuries of which there were 226 STFs, 46 falls to a lower level, 117 falls to the same level, 41 from slips, trips, or loss of balance without a fall, and 22 from other events. Of the 226 STFs, 52 were from slippery surfaces, 43 from objects on floor, and 28 from surface irregularities which were all preventable by good housekeeping and maintenance and cost \$1,543,946. Recommendations for fall preventions in the plant are discussed.

## Introduction

A project was initiated with a helicopter manufacturing company to evaluate the reduction of injuries and return on investment associated with a company safety program of interventions targeted to reduce injuries in one of their plants employing approximately 3,500 production workers. Risks of falls from elevation include working on stands around the aircraft complete with stairs, standing on aircraft for some assembly work, working on ladders, and climbing onto and off of large production equipment and machines for processing parts and machine maintenance. Risks from falls to the same level include slipping on slippery substances including ice and snow in parking lots and outside walkways, tripping on objects such as tools and parts in walkways, and tripping on irregular surfaces such as grates and holes in indoor stands and on holes and cracks in

outdoor walking surfaces.

Bell et al., [2008] used an epidemiologic approach to analyze baseline slips, trips and falls (STFs) in a hospital-based intervention study. They coded the event of STFs using the Bureau of Labor Statistics (BLS) Occupational Illness and Injury Classification Structure (OIICS) [BLS, 1992]. They further categorized the cause of the first initiating event (FIE) and developed a taxonomy of characteristics of the cause of the FIE to supplement the OIICS codes. They reported a high percentage of STFs due to preventable conditions such as slippery substances on surfaces; surface hazards such as holes, cracks, and uneven surfaces; elevated edges of rugs and mats; and falling off chairs. They then implemented a program targeting high risk jobs and areas for hazard evaluation, raising employee awareness to the importance of preventing STFs, housekeeping practices, maintenance and repair, methods of floor cleaning to increase the coefficient of friction, and slip resistant shoes for targeted employees. Employing this approach, STFs were reduced by 50-60%.

The epidemiologic approach used by Bell et al. for their baseline analysis of STF risks was applied to data from the helicopter manufacturing plant. Primary questions to be addressed were what were the leading causes of STFs in the plant with respect to plant location and what were the medical and indemnity costs associated with the injury outcomes. Recommendations for fall prevention in this plant are discussed.

## Methods

The study population consisted of 4,070 production workers who were employed between January 1, 2004 and February 28, 2008 at a large helicopter manufacturing plant. Data

were collected on workers from company records including 1) payroll records on dates and hours worked, 2) personnel records on date of birth, gender, occupation, and department, 3) workers' compensation (WC) records, and 4) company physician and nurse first report of injury records. WC and first report of injury records for each injury were merged to code cause and source of injury.

The event and source of all injuries were coded using the OIICS [BLS, 1992] by a trained OIICS coder. One of the authors (HA) read each injury narrative and verified agreement with the coder. The condition leading to the FIE of STFs was also coded (slip, trip, fall, loss of balance, or unknown) similar to the approach used by Bell *et al.* [2008] to supplement the OIICS event codes. Additionally, the condition causing the FIE of STFs was coded to supplement the OIICS event code and provide specificity peculiar to the plant. Codes on nature of injury were taken from the physician or nurse first report of injury. For the purposes of this analysis, STFs were defined as injuries with OIICS event code 1 (falls) and 215 (slip, trip, or loss of balance without a fall).

The company is self insured, and thus, all WC medical and indemnity costs from all claims filed during the study period were used for the cost analysis. For this analysis, total cost of WC claims, cost per injury, and cost per WC claim were calculated. The cost per injury is defined as the total WC cost divided by the total number of injuries (some injuries did not have WC claims filed and some had WC claims filed but no costs associated with them.) The cost per claim is defined as the total WC cost divided by the number of claims which cost \$1 or more.

Annual rates of injury per 10,000 full-time equivalents (FTE) in selected subgroups were computed by dividing the total number of injuries in the group by the total number of hours worked times 20,000,000 which is comparable to the method used by BLS [2009]. It was assumed that the total annual number of hours worked was 2,000 hours (50 weeks x 40 hours per week).

## Results

From January 1, 2004 to February 28, 2008, there

was a total of 2,378 injuries among the 4,070 employees of which 930 injuries had a WC claim costing \$1 or more. There were 226 STFs which were the fourth leading injury event among all OIICS single digit coded events (9.5% of all injuries). The leading event was bodily reaction and exertion (40.2%), followed by contact with objects (34.6%) and exposure to harmful substances (11.3%). STFs were the second leading event of lost work day (LWD) injury. Of the 226 STFs, 23 (10.2%) were LWD injuries. The rate per 10,000 FTE of LWD injuries was 14.4 for all falls, 5.8 for falls to a lower level, 8.4 for falls to the same level, and 5.0 for slips, trips, or loss of balance without a fall.

Of the 226 STFs, there were 46 (20.4%) falls to a lower level, 117 (51.8%) falls on the same level, 41 (18.1%) slips, trips, or loss of balance without a fall, and 22 (9.7%) from other events. The event associated with the highest number of falls on the same level were to the floor, walkway, or other surface (77 injuries) and onto or against objects (31 injuries). The source associated with the highest number of falls were floors of building, walkways, ground surfaces, steps, and parking lot surfaces (118 STFs, 52% of all STFs). Body motion and posture was the second most prevalent source of STFs (40, 17.7%). The most prevalent nature or diagnosis of injury for STFs from first report of injury was due to contusion (75), pain, nature unspecified (69), sprain (24), strain (27), and laceration (12).

With respect to the contributing cause of the first initiating event (FIE), of the 226 STFs, slippery surfaces contributed to 23% (52), slips on ice and snow to 13% (30), objects on the floor to 19% (43), a surface irregularity to 12% (28), chairs to 6% (13), and other causes to 40% (90) including 8% (17) due to climbing in, out of, onto or off of the aircraft and 14% (32) due to bodily reaction involving loss of balance or a misstep while walking or standing on level ground. Patterns of lost work day injuries with respect to causes of the first initiating event due to STFs were similar to that of all injuries. The total WC and indemnity costs for all injuries from January 1, 2004 to February 28, 2008 were \$13,836,424.

STFs (OIIcs event codes 1 and 215) had a total cost of \$2,238,849. Bodily reaction and exertion was the injury event associated with the highest total cost of \$8,525,108 (total cost of all bodily reaction and exertion injuries in U.S. the cost of injuries due to slips, trips, or loss of balance without a fall). However, falls (OIIcs single digit event code =1) had a higher cost per injury (\$10,108) and cost per WC claim (\$22,532) than injuries from bodily reaction and exertion (\$9313 and \$16,941, respectively). Among categories of fall events, falls on the same level had the highest total cost(\$1,405,302), cost per injury (\$12,011) and cost per claim (\$26,515).

With respect to contributing causes of a STF, the total cost was highest for STFs on slippery surfaces(\$856,043) followed by objects on the floor (\$522,408), and surface irregularities (\$165,495). However, the total cost per injury was highest for STFs on slippery surfaces (\$16,462) and objects on floor(\$12,149). Among causes contributing to slippery surfaces, slipping on ice contributed to 30 (58%) of the 52 STFs in this category and had a total cost of \$698,011 (82% of the cost of all STFs due to slippery surfaces), a cost per injury of \$23,267, and cost per claim of \$53,693.

Rates of STFs were elevated in the blades and composites department, outside walkways and parking lots, gears and transmission, hanger, and final assembly areas. The percentage of all injuries due to STFs on slippery substances was 50% in gears and transmission departments and 20-30% in blades and composite, final assembly, and hanger areas. The percentage of STFs due to objects on the floor was 18-30% in blades and composites, final assembly, gears, and hanger areas. Between fourteen and twenty-six percent of the STFs due to surface irregularities were found in the blades and composites, hanger, and outside walkways and parking areas.

## Discussion

STFs were the fourth leading cause of injury and the second leading cause of lost workday injuries for production employees at a large helicopter

manufacturing plant. The average annual rate per 10,000 FTE for LWD injuries was 5.8 for falls to a lower level, 8.4 for falls to the same level, and 5.0 for slips, trips, or loss of balance without a fall. Comparable LWD injury rates for the manufacturing industry in 2007 [BLS, 2009] were 5.2, 13.3, and 3.4 per 10,000 FTE, respectively. Thus, LWD STF rates for the helicopter plant were lower than that in the U.S. manufacturing industry.

During the 2004-2008 study period, there were 226 STFs of which 123 STFs due to slippery surfaces, objects left on the floor, and surface irregularities. These 123 STFs could have possibly been prevented by good housekeeping and maintenance practice, and comprised 54% of the total STFs, cost \$1,543,946 in WC costs, and comprised 69% of the total cost of STFs.

Although the cost to prevent STF hazards in this plant has not been estimated, it would appear that the cost to prevent many STF events could offset the cost of occupational injury in this plant. For example, spending more money to more aggressively apply ice melting chemicals on sidewalks and walkways could offset a large portion of the \$698,011 in workers compensation claim dollars spent on slips on ice and snow on outside walk ways and parking lots. Monies spent to repair floors and walking surfaces throughout the plant could offset the \$165,495 in compensation claims related to trips surface irregularities. Finally, dedicating staff time and training to the promotion of awareness to keep walking surfaces clean and dry, objects off the floor, site inspections, and housekeeping could have a large impact on the 1.5 million dollars spent on STFs due to slippery surfaces, objects on the floor, and surface irregularities in this plant over approximately 4 years. Clearly, a STF hazard audit and business case is needed to determine the return on investment of prevention measures.

Results have shown similar patterns of preventable STF injuries due to slips on slippery surfaces and trips over surface irregularities as found by Bell *et al.* [2008] in hospitals. It seems

reasonable and appropriate to implement and evaluate a STF prevention program in this helicopter manufacturing plant.

### **Recommendations are as follows:**

1. Conduct an audit of the plant to determine where and why surface contaminants are present, surfaces are in need of repair, and objects are trip hazards on the floor. Focus the audit program plant wide but ensure inclusion of high risk areas such as blades and composites department, outside walkways and parking lots, gears and transmission, hanger, and final assembly areas.
2. Repair surface irregularities including holes or cracks in grates, stands, or other walking surfaces, uneven surfaces, mats and rugs with elevated edges, uneven elevator floor with building floor, etc.
3. Examine drainage from downspouts as well as the process for ice and snow removal on outdoor walkways to identify areas where snow and ice build up on walkways.
4. Increase monitoring of walkways for ice melting chemical applications in walking areas.
5. Increase awareness among workers to immediately clean up spills from slippery substances, place caution cones over the slippery area, and remove parts, tools, and other trip hazards from walkways as soon as possible. Conduct periodic audits by supervisors and safety

officials to monitor the work place for these hazards.

6. Implement a plant promotional campaign to increase awareness to slippery substances and objects on the floor.
7. Conduct a business case analysis on the return on investment associated with the cost of these interventions assuming significant reductions in preventable injuries. Results of this epidemiologic analysis indicate that a high proportion of STFs are preventable by housekeeping and maintenance activities, that the cost of these preventable injuries is high and would likely offset much of the cost of interventions. An epidemiologic approach to the analysis of STF risk is a good first step in assessing the STF problem in a manufacturing plant and to estimate the return on investment of STF preventions.

### **References**

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