

- Myths and Misconceptions Revisited -
What are the (Statistically Significant) Methods to Prevent Employee Injuries

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ABSTRACT

A company's overall safety program becomes an important consideration to continue performing work and for procuring future contract awards. When injuries or accidents occur, the employer ultimately loses on two counts - increased medical costs and employee absences. This paper summarizes the human and organizational components that contributed to successful safety programs implemented by WESKEM, LLC's Environmental, Safety, and Health Departments located in Paducah, Kentucky, and Oak Ridge, Tennessee. The philosophy of "safety, compliance, and then production" and programmatic components implemented at the start of the contracts were qualitatively identified as contributing factors resulting in a significant accumulation of safe work hours and an Experience Modification Rate (EMR) of <1.0. Furthermore, a study by the Associated General Contractors of America quantitatively validated components, already found in the WESKEM, LLC programs, as contributing factors to prevent employee accidents and injuries. Therefore, an investment in the human and organizational components now can pay dividends later by reducing the EMR, which is the key to reducing Workers' Compensation premiums. Also, knowing your employees' demographics and taking an active approach to evaluate and prevent fatigue may help employees balance work and nonwork responsibilities. In turn, this approach can assist employers in maintaining a healthy and productive workforce. For these reasons, it is essential that safety needs be considered as the starting point when performing work.

INTRODUCTION

The United States (U.S.) Bureau of Labor Statistics (BLS) provides an interesting summary regarding fatal occupational injuries for 2005 (1):

- A total of 5,702 fatal work injuries were recorded in the U.S. in 2005, down about 1% from the revised total of 5,764 fatal work injuries recorded in 2004. The rate

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- at which fatal work injuries occurred in 2005 was 4.0 per 100,000 workers, down slightly from a rate of 4.1 per 100,000 in 2004.
- Fatal highway incidents increased by 2% in 2005 and remained the most frequent type of fatal workplace event, accounting for one in every four fatalities nationally.
 - Fatal work injuries from exposure to harmful substances or environments rose 7% in 2005. This overall increase was led by a sharp increase in the number of workers who died after exposure to environmental heat, from 18 fatalities in 2004 to 47 fatalities in 2005. Higher numbers of fatal work injuries resulting from the inhalation of caustic, noxious, or allergenic substances also contributed to the overall increase. The number of electrocutions was down slightly in 2005.
 - The private construction industry accounted for 1,186 fatal work injuries, the most of any industry sector, and about one out of every five fatal work injuries recorded in 2005.
 - Twenty-six states reported lower numbers of fatal work injuries in 2005 than in 2004. Twenty-two states and the District of Columbia reported higher numbers, and two states were unchanged. Mississippi, Montana, New Hampshire, and Wisconsin reported increases of at least 20%, while Alaska, Hawaii, Nebraska, New Mexico, and West Virginia reported decreases of at least 20%.

By comparison, radioactive and hazardous waste management activities performed at various U.S. locations and regulated by a combination of the U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), and other federal and state agencies have experienced very few fatalities, and in most cases, none at all. Safety is often promoted to such a degree that experiencing even minor injuries, such as first aids (e.g., cuts, scrapes), are viewed as unacceptable. Furthermore, it is common knowledge that within this type of work environment, a serious accident or fatality will certainly stop a project completely. Although this type of event may not shut down an entire site, it will nevertheless prompt an extensive investigation (2). The indefinite delay during the course of the investigation would obviously impact a company's overall scope of work, thus eliminating any possibility of achieving project milestones while prompting negative internal and external publicity. As a result, a company's overall safety program becomes an important consideration associated with contract submittals in order to continue performing current work, as well as for procuring future contract awards. From this perspective, safety, compliance, and **then** production should be the order of priority when performing existing work or pursuing new contracts.

However, evidence suggests that companies failing to implement the human and organizational components of an effective safety program (e.g., planning, written procedures, training, communication, and teamwork) or establishing long work hours (i.e., mandatory overtime) as part of a regular work schedule become contributing factors to employee accidents and injuries. In general, overtime is defined as more than 40 hours per week and extended work shifts are defined as shifts longer than 8 hours. Even a company having an existing stellar safety record will begin to experience an increase in employee accidents and injuries when employees perceive that safety is no longer a

company priority, or when resources, normally devoted to safety, are diverted elsewhere. In these situations, risk perceptions, behaviors, and attitudes of the employees are affected significantly. Furthermore, overtime, despite its apparent chronic harms and risks, is here to stay and continues to be appealing to employers and employees. Employers can enjoy non-wage cost savings, while employees gain access to higher wage rates and even flexible work schedules. Ultimately, the dilemma is that both employers and employees must somehow achieve a sense of balance regarding safety, compliance, and **then** production in order to operate successfully now and into the future.

PURPOSE

In 2003, Potts, Smith, and Hylko (3) qualitatively reviewed various “myths and misconceptions” associated with a typical safety program. They concluded that an early top-down, bottom-up investment, specifically in the human and organizational components of the program, can pay back future dividends, for example, by reducing employee accidents and injuries, thereby lowering the company’s Experience Modification Rate (EMR). Lowering the EMR is the key to reducing Workers’ Compensation (WC) premiums that can significantly impact a company’s “bottom line”. Even with the growing body of evidence, discussed herein, that suggests long work hours (i.e., overtime) can adversely affect the health and wellbeing of workers, this paper incorporates the results of the *Associated General Contractors of America (AGC) Study* that quantitatively (i.e., statistically) validates the earlier work of Potts, Smith, and Hylko. As a result, radioactive and hazardous waste management activities, even if they involve overtime, continue to pay dividends by reducing personnel and economic losses related to accidents and injuries while surpassing project milestones.

OVERTIME AND THE ORIGIN OF THE STANDARD WORK WEEK: THE FAIR LABOR STANDARDS ACT OF 1938 (FLSA)

Over the last two decades, American workers have been clocking more hours on the job and working more hours than workers in any other industrialized nation. Based on an Economic Policy Institute briefing paper published in 2002 (4), annual work hours are 4% higher than they were in 1980, amounting to, on average, an extra 1 hour and 30 minutes at work per week. The cumulative rise in time on the job was even higher for families. In 1998, the typical middle-income, married-couple family worked six more weeks a year than did a similar family in 1989. Workers were also clocking more overtime hours. Almost one-third of the workforce regularly worked more than the standard 40-hour week while one-fifth worked more than 50 hours. Hourly manufacturing workers, the only group tracked by government statisticians, were putting in 25% more overtime than they were a decade ago. In virtually every industry within the manufacturing sector, overtime had reached a record by the end of the 1990s.

An analysis of the wage and salary employee work hours showed that overtime work was widespread in most industries. In agriculture, mining, manufacturing, transportation, communication, and some professional services, more than 25% of all employees reported that they worked more than 40 hours per week on a regular basis. In fact, both

exempt and non-exempt workers who clocked extra hours worked an average of nearly 12 hours more than the standard work week of 40 hours in 2000. On average, approximately 20% of covered workers received overtime pay in any week (5). As a result, the annual number of hours worked per person in the U.S. surpassed Japan and most of Western Europe. Work hours in the U.S. were surpassed only by Thailand, Hong Kong, and South Korea (6).

The Fair Labor Standards Act of 1938 (FLSA) (7, 8, 9) is one of the landmark pieces of legislation of President Franklin D. Roosevelt's New Deal. Provisions of the FLSA established a national minimum wage and a maximum number of hours for the work week, set standards for wage and hour recordkeeping, and forbade the employment of children. The original provisions of the bill provided for a 25-cents-per-hour minimum wage and limited the work week to 44 hours, but did not apply to public agencies. In 1940, the work week was reduced to its current 40 hours by an amendment to the FLSA. Since then, the FLSA has been amended more than 20 times since its inception. Many of these amendments simply raised the minimum wage.

Today, the FLSA affects more than 80 million full-time and part-time workers in the private sector and in federal, state, and local governments. The FLSA, which regulates overtime, currently imposes no limits on overtime hours, nor does it prohibit dismissal or any other sanction for declining overtime work. Rather, the FLSA merely requires that payroll employees who are not "exempt" from the overtime requirements of the FLSA be paid an overtime premium of at least one-half of regular rate of pay for each hour worked over 40 during a work week.

OVERTIME, INJURIES, AND ACCIDENTS

A growing body of evidence suggests that long work hours adversely affect the health and wellbeing of workers. Although acute injuries and fatalities receive most of the attention within a typical safety program, studies have associated overtime and extended work schedules with an increased risk of hypertension, cardiovascular disease, fatigue, stress, depression, musculoskeletal disorders, chronic infections, diabetes, general health complaints, and, lastly, interference with social and domestic life.

A study by the National Institute for Occupational Safety and Health published in 2004 (6) provides a comprehensive review of 52 research reports that examined the associations between long work hours and illnesses, injuries, health behaviors, and performance. Approximately 20% of the studies were conducted in the U.S., 28% in Asia, and 35% in Europe. The studies were conducted in field settings, except for three laboratory investigations. The most frequent types of work studied were health care, white collar, and manufacturing. The age groups studied ranged from young adults to older workers in their 60s, but only two studies specifically addressed the relationship of age to health effects. In 40% of the studies, men were examined exclusively, as compared to 10% of studies that examined only women. The report was restricted to a description of the findings and methods and was not intended as an exhaustive discussion of all important issues related to long work hours. Findings and methods were

summarized as reported by the original authors, and the study methods were not critically evaluated for quality.

Nevertheless, 16 of 22 studies addressing general health effects associated overtime with poorer perceived general health, increased injury rates, more illnesses, or increased mortality. One meta-analysis of long work hours suggested a possible weak relationship with preterm birth. Overtime was associated with unhealthy weight gain in two studies, increased alcohol use in two of three studies, increased smoking in one of two studies, and poorer neuropsychological test performance in one study. Some reports did not support this trend, finding no relationship between long work hours and leisure-time physical activity, in two of three studies, and no relationship with drug abuse, in one study.

A pattern of deteriorating performance on psychophysiological tests, as well as injuries while working long hours, was observed across study findings, particularly with very long shifts and when 12-hour shifts were combined with more than 40 hours of work a week. Four studies that focused on effects during extended shifts reported feelings of decreased alertness and increased fatigue, lower cognitive function, declines in vigilance on task measures, and increased injuries between the 9th-to-12th hour of work. Two studies examining physicians who worked very long shifts reported deterioration on various measures of cognitive performance. A pattern of more adverse findings was detected across studies when 12-hour shifts were combined with other work-related demands.

Six studies examining 12-hour shifts combined with more than 40 hours of work per week reported increases in health complaints, deterioration in performance, or slower pace of work. Two studies comparing 8- and 12-hour schedules during day and night shifts reported that 12-hour night shifts were associated with more physical fatigue, smoking, or alcohol use. Two studies examining start times for 12-hour shifts reported that decrements in alertness or more health complaints were associated with early 6:00 a.m. start times. One study examining 12-hour shifts in hot work environments reported a slower pace of work as compared with shorter shifts. Another study examining high workloads during 12-hour shifts showed increased discomfort and deterioration in performance as compared with shorter shifts.

More definitive statements about differences between 8-hour and 12-hour shifts are difficult because of the inconsistencies in the types of work schedules examined across the studies. Work schedules differed by the time of day (i.e., day, evening, night), fixed versus rotating schedules, speed of rotation, direction of rotation, number of hours worked per week, number of consecutive days worked, number of rest days, and number of weekends off. All of these factors could have interacted with overtime and influenced study results. Also, some studies did not report how many hours participants worked per week or other details about the work shifts, which complicated the assessment of their results. The many differences in the 8- and 12-hour shift schedules studied may have accounted for their contradictory findings. Few studies examined related topics, such as the combined influence of shift work and overtime, or how the workers' control over

their work time and mandatory overtime might influence their health. Some studies examined functional abilities or injuries during the 1st-to-12th hour of work, but little has been reported about effects after the 12th hour.

Few studies have investigated the influence of long working hours on the health and safety of women or older workers; how long working hours influence workers with pre-existing health problems; or how the hours relate to symptom management and the course of common chronic diseases. Little data are available regarding the influence of occupational exposures (e.g., chemical, heat, noise, lifting) in combination with long working hours on health and safety.

A Discussion on Work Schedules and Previous Studies

Although there are a significant number of published studies examining long working hours, questions remain on how overtime and extended work shifts influence worker health and safety. Work schedules differ in many ways and more than 10,000 schedules are in use worldwide (6), but consideration of shift duration highlights two common shift categories, each with their own permutations, designed to provide 24-hour coverage (e.g., three eight-hour shifts or two 12-hour shifts) (10).

Twelve-hour systems are popular with shift workers because they compress the working week and offer greater opportunity for time away from work. After the introduction of 12-hour shifts, some studies have reported benefits in positive attitudes about travel to work and time off, improved staff morale, and reduced absences due to sickness. However, unfavorable outcomes have also been reported. For example, the reductions in patient care quality and shift aversion have been cited as major problems in hospitals. The major arguments against 12-hour shifts tend to revolve around the concern that they promote fatigue and compromise alertness and performance, thereby reducing operational efficiency or safety. Consequently, the research literature cautions against longer work shifts, especially 12-hour night shifts, where public safety is a main consideration. This potential impairment to functioning exists because under shift working conditions, and especially when required to work at night, circadian rhythms are disrupted as a result of having to alter the activity-rest cycle. However, the research evidence on compressed work weeks tends to be less supportive of this position. For example, it has been concluded that, if anything, the impact of such scheduling is beneficial. It was shown that compressed schedules brought moderate decreases in sickness absence, small increases in productivity, large increases in schedule and job satisfaction, but also moderate increases in fatigue.

The authors acknowledge that existing research can be viewed as inconsistent and contain serious methodological shortcomings. Reviews have generally concluded that long work hours are potentially dangerous to workers' health showing evidence of a relationship between long work hours and an increased risk of occupational injuries among workers in specific occupations and industries, such as construction workers, nurses, anaesthetists, veterinarians, other healthcare professionals, miners, bus drivers, long distance truck drivers, fire-fighters, and even nuclear power plant workers.

However, regarding shift work, for example, there is often failure to account for potential confounding factors. For instance, jobs performed during long working shifts might be inherently more dangerous, or people working in extended-hour schedules might have different personal characteristics (e.g., age, gender, or underlying health status) that affect their injury risk and stress. Moreover, health-related phenomena and our overall understanding of these linkages remain limited, because most studies use only self-reported evaluations of job control. Additionally, the vast majority of existing studies have been performed in Europe, Asia, and Scandinavia. Only a handful of studies have been conducted in the U.S.; none of them have involved large sample sizes or study populations representing a mix of industries and occupations, but rather unique industry-specific circumstances that limit applicability of the findings.

The Dembe Study

The most useful study to analyze the impact of overtime and extended working hours on the risk of occupational injuries and illnesses among a nationally representative sample of working adults from the U.S. was published by Dembe, *et al* in 2005 (5), herein referred to as the *Dembe Study*. The conceptual basis for the study was adapted from a theoretical model proposed by Shuster and Rhodes in 1985 (11). In this model, overtime and long work hours were presumed to affect the risk of workplace accidents by precipitating various intermediary conditions in affected workers, such as fatigue, stress, and drowsiness. The pathway linking a demanding work schedule to the intermediary condition and ultimately to a workplace accident can be mediated by a variety of individual and environmental factors, including personal characteristics, such as age, gender, health status, job experience; job factors, such as intensity of work, exposure to hazards; and organizational factors, such as overtime policy, supervision (Figure 1).

The *Dembe Study* hypothesis was that working overtime or an extended work schedule increased the likelihood of reporting an occupational injury or illness compared to workers having less demanding schedules. Moreover, the study hypothesized that the risk of injury increased with increasing volume of work performed in the demanding schedule. The study was based on responses from 10,793 Americans participating in the National Longitudinal Survey of Youth (NLSY). The information, contained in 110,236 job records representing 89,729 person-years of accumulated working time, covered 13 years (ca. 1987-2000) and was used to evaluate workers' job histories, work schedules, and occurrence of occupational injury and illness. Aggregated incidence rates in each of five exposure categories were calculated for each NLSY survey period. Multivariate analytical techniques were used to estimate the relative risk of long working hours per day, extended hours per week, commute times, and overtime schedules on reporting a work-related injury or illness, after adjusting for the influence of several mediating factors such as age, gender, occupation, industry sector, and geographical region. The specific mechanisms by which fatigue, stress, or other intermediary conditions bring about a workplace accident were not investigated in the study.

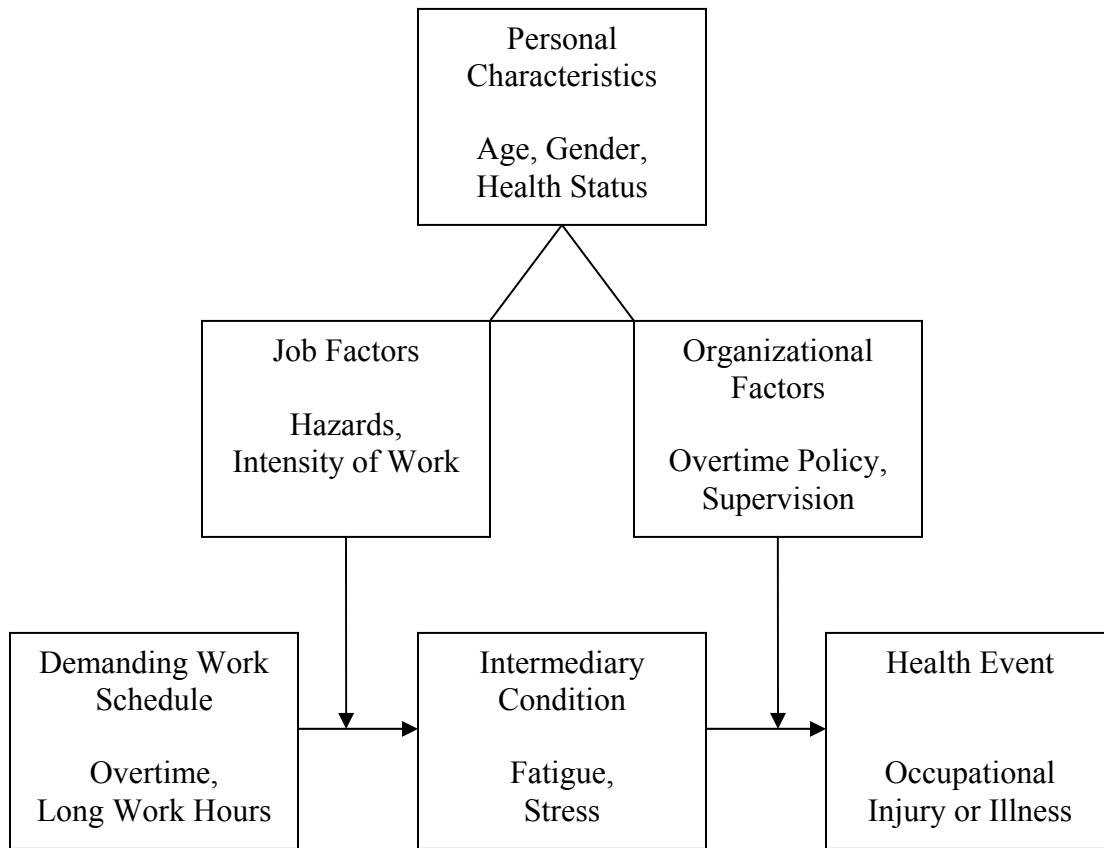


Figure 1. Conceptual model of the relationship between demanding work schedules and occupational injuries and illnesses

After adjusting for those factors, working in jobs with overtime schedules was associated with a 61% higher injury hazard rate compared to jobs without overtime. Also, working at least 12 hours per day was associated with a 37% increased hazard rate and working at least 60 hours per week was associated with a 23% increased hazard rate. A strong dose-response effect was observed, with the injury rate (per 100 accumulated worker-years in a particular schedule) increasing in correspondence to the number of hours per day (or per week) in the workers' customary schedule.

The results of this study suggested that jobs with long work hours were not necessarily more risky merely because they were concentrated in inherently hazardous industries, hazardous occupations, or due to the demographic characteristics of employees working those schedules. The findings were consistent with the hypothesis that long work hours indirectly precipitated workplace accidents through a causal process by inducing fatigue or stress in affected workers. Furthermore, this study of nationally representative data from the U.S. adds to the growing body of evidence indicating that work schedules involving long hours or overtime substantially increases the risk for occupation-related injuries.

Quantifying Fatigue

Why, in the face of considerable evidence, is the potential for harm from fatigue underestimated? Perhaps the answer lies in the fact that fatigue is a common experience and that adverse events do not always accompany every occasion of fatigue. First, the presence of fatigue, like the presence of alcohol, increases the risk of, rather than guarantees the occurrence of, an injury due to decreased performance capacity. Second, the nature of the experience gives the illusion of control. During the development of fatigue, alertness waxes and wanes so that the overall and inevitable decline in performance is not necessarily recognized. Changes in stimulation, such as increasing ventilation, going for a walk, etc., appear to restore alertness, when in fact they are temporary interruptions of a continuing decline in alertness. Third, there is no simple objective test of fatigue, equivalent to a breath analyzer for alcohol or an employee drug screening that can be applied after an injury has occurred. The contribution from fatigue is secondary based on established causal factors implicating fatigue in performance impairment such as time awake, prior wake-rest schedules, time of day, and characteristics of the accident or other injury-causing events (12).

PROGRAMS TO PREVENT EMPLOYEE FATIGUE AND IMPAIRMENT

Administrative policies and objectives have already been implemented in the commercial nuclear power industry, as well as the DOE, to prevent situations where employees are either fatigued or impaired while under the influence of any substance that may adversely affect their ability to safely and competently perform their duties.

Generic Letter 82-12 (GL 82-12): Nuclear Power Plant Staff Working Hours (13)

The controls established in GL 82-12 would assure that, to the extent practicable, personnel were not assigned to shift duties while in a fatigued condition that could significantly reduce their mental alertness or their decision-making ability. The objective was to have operating personnel work a normal 8-hour day, 40-hour week, while the plant is operating. For example, in the event that unforeseen problems required working substantial amounts of overtime, such as extended shutdown periods for refueling, major maintenance, or major plant modifications, the following guidelines were to be followed:

- An individual should not be permitted to work more than 16 hours straight (excluding shift turnover time).
- An individual should not be permitted to work more than 16 hours in any 24-hour period, nor more than 24 hours in any 48-hour period, nor more than 72 hours in any seven day period (all excluding shift turnover time).
- A break of at least eight hours should be allowed between work periods (including shift turnover time).
- Except during extended shutdown periods, the use of overtime should be considered on an individual basis and not for the entire staff on shift.

Very unusual circumstances requiring deviation from the above guidelines were to be authorized by high levels of management, documented, and available for NRC review.

Fitness-for-Duty (14) and Workplace Substance Abuse Programs (15)

In addition to employee fatigue issues, fitness-for-duty and workplace substance abuse programs in both NRC and DOE work environments, respectively, have been instituted to achieve the ultimate goal of a drug-free work place. These programs provide reasonable assurance that personnel will perform their tasks in a reliable and trustworthy manner and are not under the influence of any substance, legal or illegal, or mentally or physically impaired from any cause, which in any way adversely affects their ability to safely and competently perform their duties. Measures, such as random employee drug screening, are in place to provide reasonable measures for early detection of employees in designated positions that are not fit to perform their work activities. In most instances, employee assistance programs consisting of counseling, referral, and educational services concerning illegal drug use and other medical, mental, emotional, or personal problems of employees, particularly those which adversely affect behavior and job performance, are in place to assist with employee rehabilitation.

EMPLOYER LOSS AND THE COST OF POOR PERFORMANCE

When injuries or accidents occur, the employer ultimately loses on two counts - increased medical costs and employee absences. For example, the high rate of lost-time injuries in construction has contributed to workers' compensation (WC) premiums remaining above 25% of employer payrolls, reaching a record high in the mid-1990s. Estimates show that for three key construction trades (i.e., carpenters, bricklayers, structural ironworkers), employers paid \$28.60 in WC premiums per \$100 of payroll in 1994 (16).

Reform programs in some states and a flood of new insurance providers led to discounting of premiums by WC insurance providers in the late 1990s. However, combined losses of \$1.9 billion by some providers were expected to cause a 10-to-20% rise per year for the next several years. In 2000, the average premium of \$25.11 per \$100 of payroll for carpenters, bricklayers, and structural ironworkers had already returned to the prediscounting period levels. Given the projected increase, the negative impact of premiums on a firm's ability to compete will subsequently increase. Therefore, controlling direct and indirect costs of work-related injuries can be the difference between a profitable company and one that is forced to close.

The Experience Modification Rate (EMR)

Workers' compensation premiums represent the major component of the direct costs of injuries within construction. Employers pay a premium to an insurance company in return for insurance coverage. In WC, this premium, also called "the manual premium", is calculated by multiplying a specified rate, or "manual rate", assigned to a specific industry classification by the number of hundreds of dollars of the employer's payroll. An individual company's premiums are calculated by multiplying its EMR by the manual

rate set by the insurance industry for the business type. Briefly, the EMR is designed to reflect variation of an employer's actual experience from the expected or average experience for the industry classification. This comparison of actual-to-expected losses can result in either a reduction or increase in premiums. Companies with lower-than-average losses are assigned an EMR <1.0 , while companies with higher-than-average losses are assigned an EMR >1.0 .

The following example dramatizes the impact of EMR on the company's "bottom line". Assuming an average WC manual rate of \$25 on every \$100 dollars of payroll, a small 30-employee firm with an EMR of 1.3 (based on worse-than-average losses) and an annual payroll of \$600,000 pays \$195,000 in annual WC premiums. A similar-sized firm with an EMR of 0.7 (due to less-than-average losses) would pay only \$105,000 per year, a difference of \$90,000. Since understanding the impact of the EMR is key to reducing WC premiums, greater savings in direct WC costs can be realized when a company's EMR is <1.0 .

Most contractors can calculate the direct costs of injuries based on WC premiums, but many may not recognize the magnitude of the indirect costs. For example, if an employee falls from a defective ladder, WC pays for the direct medical expenses estimated at \$7,500, but the indirect costs to the employer are more than double that amount. These costs include \$8,500 in production loss, \$4,000 to replace the injured worker, \$2,600 WC premium increase, \$1,000 in overhead costs, \$250 for foreman's wages connected with the accident, and \$1,000 in possible Occupational Safety and Health Administration (OSHA) fines. Therefore, a total of \$17,350 must be absorbed by the contractor. For perspective, the ratio of indirect to direct costs can vary as high as 20 to 1.

THE AGC STUDY

The Tennessee Chapter of the Associated General Contractors of America (AGC) performed a cross-sectional descriptive research study, herein referred to as the *AGC Study*, of 305 Tennessee-based AGC member companies designed to identify safety program elements employed by chapter contractors and to assess the impact of those elements on safety performance. With more than 8,000 construction contractors and 14,000 specialty contractors as members, AGC is the nation's largest and oldest construction trade association (AGC of America) (16). The study instrument consisted of a 48-item self-report questionnaire designed by faculty members of the University of Tennessee Department of Health and Safety Sciences and the Department of Industrial Engineering. The 48 items were derived from a literature review on program elements considered to be indicative of a sound safety program. The questions addressed the contractor's business; safety policies, procedures, and processes; safety program elements; and safety performance. The questionnaire's validity was assessed by an expert review panel, and a test/retest procedure performed over a four-week period demonstrated instrument reliability through the observed consistency of the measurements.

Of the 305 companies, 89 (29%) responded. Respondents included companies ranging in size from four to 196 employees. The average age of the businesses was 32 years, with a range between three and 110 years. Fifty-four (61%) of the respondents described themselves as general contractors with 58 (65%) stating that they worked as a subcontractor. Company locations were distributed across the state. Fifty-one (57%) respondents reported having a full-time safety manager.

“Statistically Significant” Results

The research methodology generated information on the frequency of occurrences within certain categories. For example, companies were sorted by whether they had an EMR <1.0 or ≥ 1.0 . The total frequency of safety attributes, such as employment of a full-time safety manager, were then counted for each of the two EMR categories. Grouping of data by category results in nominal data. The most popular statistical test of nominal data is chi-square, which is used to test whether frequency differences between groups have occurred on the basis of chance. The statistical probability (p) that differences between groups are attributed only to chance is called alpha and is typically set at 0.05. For example, if $p < 0.05$, then it is stated that there is less than a 5% chance that observed differences between groups is attributed to chance alone. Referencing the results of the chi-square analysis presented from the study, the greater-than-expected number of full-time safety managers employed by companies with EMRs <1.0 compared to companies with EMRs ≥ 1.0 is 0.015 or 15 out of 1,000. Based on an alpha of 0.05, it can be concluded that the observed difference is statistically significant.

Recalling that construction remains the most dangerous of all U.S. industries according to the BLS, study results identified a significant difference ($p \leq 0.05$) for those companies reporting: 1) lower WC cost as measured by EMR, 2) employment of 50 or more workers, 3) employment of a full-time safety manager, and/or 4) clearly defined safety roles/responsibilities.

1) WC Costs - WC costs were evaluated by comparing contractor EMRs. Contractors with a higher EMR were considered to have higher WC costs. Respondents' EMRs were grouped according to whether the rate was <1.0 (low EMR) or ≥ 1.0 (high EMR). Companies that reported an EMR <1.0 reported a significantly higher number of key safety program elements. They also reported employing a full-time safety manager (68%) than did those reporting a higher EMR (33%). Companies with a lower EMR also reported a higher use of pre-job safety briefings (51%) than those with a higher EMR (20%). A greater number of written drug/alcohol use prevention programs were found among those with a lower EMR (91%) compared to those with a higher EMR (67%). Those reporting attendance at local and regional safety meetings sponsored by AGC had a significantly lower EMR (44%) than did those with higher EMR (0%).

2) Company Size - Safety performance and safety program content varied by company size. A significantly higher number of small companies, defined as having fewer than 50 employees, reported having an EMR ≥ 1.0 than medium companies employing 51 to 100 employees and large companies employing more than 100 workers. A greater number of

medium-to-large companies reported that they performed drug testing and participated in safety conferences than did smaller companies.

3) Full-Time Safety Manager - Employment of a full-time safety manager was predictive of the self-reporting of specific safety processes and practices. A significantly higher number of companies reported that they presented pre-job safety briefings when employing a full-time safety manager (53%) than those that did not employ a full-time safety manager (23%). A higher number of companies with a full-time safety manager reported the existence of a written drug/alcohol prevention program (92% vs. 70%) and company-performed drug testing (100% vs. 82%). In addition, companies with full-time safety managers were significantly more likely to report that they: 1) tracked injury and illness costs (74% vs. 46%), 2) performed weekly walkaround safety inspections (70% vs. 30%), and 3) attended AGC training programs (77% vs. 54%).

4) Safety Roles and Responsibilities - Companies that reported defined roles and responsibilities of persons responsible for safety reported a higher number of key safety program elements. A significantly higher number of companies reporting written and clearly defined safety roles and responsibilities reported safety policies and procedures for drug and alcohol prevention (91% vs. 50%) and emergency preparedness programs (62% vs. 17%). They also reported tracking: 1) injury/illness costs (74% vs. 38%), 2) first-aid cases (69% vs. 15%), 3) near-misses (33% vs. 0%), 4) conducting safety training (86% vs. 46%), and 5) walkaround safety inspections (67% vs. 20%). Companies reporting significantly higher numbers of key safety program elements reported that the person responsible for safety reported to executive management and attended senior management meetings.

The aforementioned study supports the findings of previous qualitative research on the five effective human and organizational components associated with any successful safety program:

1) Management Commitment and Safety Expenditures - Consistently identified as a critical component of an effective safety program. The importance of safety roles/responsibilities was further underscored by companies having a written health and safety program, and a safety incentive program.

2) Employee Involvement (e.g., safety committees, employee concerns program) – Viewing the employee as the “ultimate shareholder” increasingly came to be recognized as the primary key to an effective safety program.

3) Worksite Analysis - Sometimes referred to as job safety analysis in the construction trades, was present in companies having a full-time safety manager, implementing a safety inspection program (e.g., hazard analysis, accident investigations, pre-job/pre-task planning) or actively tracking the cost of worksite injuries and illnesses.

4) Hazard Prevention and Control - Credited as the single most important element that can directly reduce workplace injuries and was found to be significant in companies

reporting the existence of written drug/alcohol use prevention programs and reporting lower EMRs, that also included having accessibly to first-aid and medical services.

5) Training - An essential component of an effective safety program that contributes to a higher presence of clearly defined roles and responsibilities. A significant number of companies using pre-job safety briefings reported lower EMRs, and attended local and regional AGC safety events.

These elements are consistent with OSHA as being key to successful accident prevention.

“If you do the right things in the field, the numbers take care of themselves.”

James M. Hylko

WESKEM, LLC is a field-response waste management company currently located in Oak Ridge, Tennessee. The WESKEM-Paducah, Kentucky contract that started in February 2000 was completed in April 2006. Specifically, the Paducah work force was comprised of over 200 salary, bargaining-unit, and sub-tier subcontractor employees. The employees were responsible for the collection, database inventory, characterization, sorting, treatment, packaging, interim storage, and transportation associated with direct handling of asbestos, polychlorinated biphenyls, including hazardous, radioactive, and mixed wastes.

Previously combined and site-specific safety milestones consisted of the following:

- WESKEM, LLC (Paducah + Oak Ridge) achieved over 800,000 safe work hours from start up in 1999 through August 2002.
- WESKEM-Paducah initially achieved over 665,000 safe work hours without a recordable injury or lost workday case when it started operations on February 28, 2000 through January 2003.
- WESKEM-Paducah accumulated over 1.6 million hours across Waste Disposition/DOE Material Storage Area (DMSA) projects (the Recordable Injury Incidence [RII] rate = 0.7, 2002-2005) and the Scrap Metal Removal Project (RII = 0.0, 2002-2005) without any “days away from work” injuries or illnesses from the start of the contract in February 2000 through the end of the contract in April 2006.
- Over 500,000 hours were accumulated on the DMSA project without a recordable injury or illness from the start of the contract in March 2001 through the end of the contract in April 2006.

In connection with the previous results reported by Potts, Smith, and Hylko (3) and the *AGC study* (16), these significant achievements can be traced back to the company’s president and senior management actively participating in the Environmental, Safety, and Health (ES&H) program, implementing the Department of Energy’s Integrated Safety Management System, already having similar programs in place identified in the *AGC study*, and challenging its employees to continuously improve in the areas of safety, compliance, and **then** production. This success was further validated while performing

high-hazard, hands-on, and invasive field activities involving hazardous, radioactive, and explosive waste materials even with the aforementioned concerns associated with employee overtime. As a result, accident and injury rates over the past six years (2000-2006) remained steady and below industry averages, thus reducing WESKEM, LLC's EMR below 1.0. Table I summarizes WESKEM, LLC's injury/illness rates and EMRs over the past six years (2000 through 2006) quantifying a safety program that is programmatically effective.

Table I. WESKEM, LLC's Injury/Illness Rates and EMRs (2000 – 2006)

Years	RII Rates	LWC-R Rates	LWC-A Rates	EMR
2000	1.2	0.8	0.8	1.0*
2001	1.6	0.0	0.6	1.0*
2002	0.8	0.0	0.6	1.0*
2003	1.3	0.5	0.3	0.95
2004	1.5	0.5	0.5	0.93
2005	0.5	0.0	0.3	0.95
2006	1.1	0.0	0.6	0.94
	Combined	Combined	Combined	
2000 thru 2006	1.1	0.3	0.5	

*Time in which the company had not yet accumulated. The rating of 1.0 is issued by the NCCI until a company accumulates the needed time, e.g., the previous three years. WESKEM, LLC began work in Oak Ridge, TN in 1999 and in Paducah, KY in 2000.

CONCLUSION

This paper summarizes the human and organizational components that contributed to successful safety programs implemented by the WESKEM, LLC ES&H Departments in Oak Ridge, Tennessee (1999-Present), and Paducah, Kentucky (2000-2006). The philosophy of “safety, compliance, and then production” and programmatic components implemented at the start of the contracts were qualitatively identified as contributing factors resulting in a significant accumulation of safe work hours and an EMR of <1.0. Furthermore, the *AGC Study* quantitatively validated components, already found in the WESKEM, LLC programs, as contributing factors to prevent employee accidents and injuries. Therefore, an investment in the human and organizational components now can pay dividends later by reducing the EMR, which is the key to reducing Workers' Compensation premiums.

Companies experiencing unacceptable safety performance metrics can reduce losses and improve their overall “safety, compliance, and then production” goals by:

- Hiring a qualified full-time safety manager that reports directly to executive management.
- Assigning the safety manager responsibility for developing a comprehensive written health and safety plan that includes pre- and post-job briefings, a drug-and-alcohol prevention program, tracking and trending of all injuries and first-aid

cases, implementing a safety inspection program, and forming a joint labor/management safety committee.

- Approaching safety as a skill that should be developed at all levels of the organization.
- Sending the safety manager, management, and members of the joint labor/management safety committee to local safety conferences.

This information should be used by both employees and employers to prevent occupational injuries and illnesses, promote overall worker health, and minimize the adverse consequences to affected workers. Also, the accompanying literature reviews support the philosophy that prevention of workplace injuries and illnesses requires a multifaceted approach that combines comprehensive hazard identification and control, ergonomic job design, worker training, medical surveillance, competent supervision, and a workplace culture and organization that promotes safety and health.

Furthermore, the results of this paper suggest that special attention needs to be paid to establishing protective measures for employees working shift work and/or overtime. Since there are a variety of factors that can influence individual work and non-work preferences, the impacts from shift work and overtime can have both positive and negative outcomes. Personal experience of the authors suggest that preferred hours of work fluctuate for employees depending on years of experience. For example, as individuals age, their life phases change, resulting in dependent and parenting responsibilities (e.g., children, partner, older parents, relatives), financial commitments, physical difficulties (e.g., sleep disturbances, dietary requirements), and work responsibilities that they did not necessarily have when they originally started their employment. These factors influence an employee's personal life and ultimately the way activities are prioritized. Therefore, it has been observed that shift workers in their first 5 years and those in their 30th-year-plus of shift work identified night work as a low priority. However, shift workers with 17-to-30 years' experience indicated a preference for work any time across the week. Overall, shift workers extended their preferred work hours to include evenings and weekends. Controls adhered strongly to current societal norms, suggesting that an employee initially undertaking shift work and even overtime may have a less restrictive perception of time and its use early in their careers that will likely alter over time (17).

Knowing your employees' demographics can yield a successful outcome for both employees and employers. Since different groups of workers have different needs at different times in their lives, incorporating these needs into working time arrangements may help employees balance work and non-work responsibilities. In turn, this approach can assist organizations in maintaining a healthy and productive workforce. Attrition, if an issue, may potentially be curtailed to a more manageable level.

In addition, fatigue is not new, nor is knowledge about its potential for harm. Convincing evidence about the risk and actual consequences has been slower to accumulate. Nevertheless, employers should not underestimate the obvious factors that can contribute to fatigue, such as working after extended wakefulness, after a night without sleep, after

sleep has been restricted, or at vulnerable times of the day and night. In addition to existing hazard identification and mitigation procedures applicable to all jobs, protective measures should include employer-sponsored health promotions and educational programs focusing on impacts from long work schedules, maintaining good sleep and nutrition, getting daily physical exercise, and regular medical care.

The information contained in this paper is universally applicable to other disciplines wanting to achieve a sense of balance regarding safety, compliance, and **then** production. For these reasons, it is essential that safety needs be considered as the starting point when performing work.

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