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Fatigue Management in the Electric Utility Industry

Characterization and Mitigation Approaches

Abstract

The purpose of this study was to help electric utilities obtain a better understanding of the causes of fatigue in the workplace, both from workplace factors and from employee habits on- and off-the-job, and to identify mitigation measures.

The project consisted of two parts: an operational needs assessment to investigate workplace sources of fatigue and an employee survey to identify employee habits that may introduce fatigue. This information can ideally be used to develop strategies and countermeasures—for example, educational programs or scheduling policies—to better manage and reduce the risk that fatigue poses in the workplace. These assessments were performed at five electric utilities, with four sites per company.

This report identified five major insights into the extent of fatigue management challenges in the surveyed companies. The report also provides recommended mitigation measures.

Keywords

Employee survey
Fatigue
Fatigue risk
Risk assessment
Workplace safety

Executive Summary

PRIMARY AUDIENCE: Electric utility safety, health, and wellness professionals

SECONDARY AUDIENCE: Electric utility human resources professionals; power delivery and generation construction, operations, and maintenance management

KEY RESEARCH QUESTION

What is the extent of fatigue management challenges in the electric utility industry? What mitigation measures could be applied to reduce fatigue, leading to potential reductions in serious injuries and fatalities, absenteeism, non-fatal injuries, and other consequences of fatigue?

RESEARCH OVERVIEW

Electrical utility work, which includes the transmission, distribution, and generation of electric power, is among the 10 most hazardous jobs in the United States and the third deadliest occupation in the construction industry, according to the Bureau of Labor Statistics. Because electric utility work is already inherently hazardous, it follows that fatigue in these workers can exacerbate already elevated chances of incidents and injuries. This study seeks to shed additional light on previous studies and produce results that can be used by industry practitioners to enhance the management of fatigue in the electric utility industry.

The research team solicited volunteers from electric utility companies funding EPRI Program 62, Occupational Health and Safety. Five EPRI-member companies with good geographical representation from across the continental United States volunteered to participate in this study. Each member company had four individual locations (worksites) participate, for a total of 20 individual worksites and 1,375 employee responses. To achieve the objectives of the project, the researchers developed two questionnaires: the operational needs assessment and the employee survey. The results for the study in this report are organized by each questionnaire and are presented in terms of the number and percentage of worksites and employees reporting on each question.

KEY FINDINGS

Although there were small variations in the areas of fatigue risk across the 20 different worksites, five trends stood out across the worksites in both the operational needs assessment and the employee survey:

- **Heavy reliance on overtime and long hours on the job**. Although many employees indicated that overtime can be both mandatory and voluntary, the employers and employees reported a significant amount of overtime—particularly during storm restoration periods. This also translates to long hours spent on the job with shifts over 12 hours. Combined with overtime, workers in the electric industry often face many consecutive hours of work.
- **Variance in planned versus unplanned schedules at worksites**. A large portion (40%) of the worksites reported having a variance of weekly or more, meaning that employees will work more hours than what they are scheduled during the week. This variance has compounding effects on fatigue, such as more consecutive days/nights of work, extended work shifts, disruption of regular sleep pattern, and fewer days off between shifts.
- **Lack of fatigue risk management system (FRMS) plans in place at worksites**. Although many worksites had some components of an FRMS, such as fitness-for-duty assessments and "stop work" authority, few worksites had an actual fatigue risk management plan.

The individual components that worksites have in place could be the building blocks to form a comprehensive fatigue management program.

- **Room for improvement in fatigue safety culture**. Only about half of the workers across the worksites agreed that their employer sees fatigue as a safety issue and that their employer encourages breaks. Employers could also engage in more efforts to communicate that they care how much rest their workers get outside of work and to consider their workers' ability to get sleep when scheduling shifts.
- **Severe human performance consequences of storm restoration periods and unplanned outages**. It was expected that workers would experience consequences as a result of this type of work. The employee survey showed that the majority report long hours and lack of sleep as the top consequences—both of which are fatigue risk factors. Many employees reported that their problem solving, situational awareness, and decision making are affected because of restoration periods and unplanned outages.

WHY THIS MATTERS

As electric utilities continue to drive to reduce all injuries—and specifically to reduce serious injuries and fatalities—better characterization of fatigue and implementing fatigue management programs can play an important role in such endeavors. All EPRI-member organizations, even those who did not participate in the study, will be able to derive value from insights contained in this report on the extent of fatigue challenges and suggested mitigation measures.

HOW TO APPLY RESULTS

EPRI-member companies can apply the methodology used in this project to characterize fatigue management challenges in their operations and use the suggested mitigation measures contained in this report.

LEARNING AND ENGAGEMENT OPPORTUNITIES

- In addition to this report, other fatigue management resources are available, for example, by downloading the Employer Toolkit for fatigue at work at www.nsc.org/fatigueatwork.
- EPRI Program 62 plans to continue fatigue management research in 2020.
- EPRI Program 62 has produced additional resources that address elements of fatigue management, including heat stress, ergonomics, and driving safety.

EPRI CONTACT: Eric Bauman, Principal Technical Leader and Program Manager, ebauman@epri.com

PROGRAM: Occupational Health and Safety, P62

1. Introduction

Electrical utility work is among the 10 most hazardous jobs in the United States and the third most deadly occupation in the construction industry, preceded only by roofers and steel workers [1]. In fact, in 2014, the all-industry fatality rate in the United States was 3.3 per 100,000 full-time equivalent (FTE) workers, while the fatality rate for electrical utility workers was nearly six times that at 19.2 per 100,000 FTE workers [2]. These losses generate an unbearable cost—beginning with the emotional and social damage caused by the irreplaceable loss of human lives, followed by the direct and indirect costs of accidents and fatalities that impact the financial stability of companies, their social perception, and the morale of their workers [3, 4].

Annual productivity gains are part of many organizational goals. Employees may seek to increase their income by working more hours, and they have family and social obligations after work. Time for recovery rest breaks and restorative sleep seems like a luxury that fewer people and organizations provide. With all these factors, fatigue is becoming a major concern for U.S. employees and employers.

Incidents in safety-critical industries can have serious consequences for employees, the public, and employers. It is essential to address factors that contribute to high injury and fatality rates. Nearly every American employee (97%) is at risk for fatigue, and fatigue likely affects every workforce [5].

Safety-critical industries have higher risks because the impact of fatigue is more than just lower productivity. Safety incidents endanger not only the employees involved, but also all those around them. In addition, increased health care costs, lawsuits, breach-of-contract issues, and lost business are just a few of the significant financial costs of fatigue that organizations may experience. Although the cost of fatigue can be difficult to isolate from other financial hits that organizations can take, it is estimated that health and well-being issues in general can cost employers in the United States upwards of $1,700 per employee per year [6].

In the last five decades, since the Occupational and Health Safety Act of 1970, industry professionals and researchers have developed and implemented numerous safety improvements in the electric utility sector, such as better training, more ergonomic and safer equipment, personal protective equipment, hotsticks, and a strong safety culture [7]. Nonetheless, further efforts are needed to reduce the disproportional accident and fatality rates of this sector.

The study of human factors such as worker fatigue as part of the accident causation process is a new and very promising field of study in the electric transmission and distribution (T&D) sector and the electric utility industry as a whole. The research performed by the National Safety Council (NSC), Ulises Techera (University of Colorado Boulder), and others in the past five years indicates that addressing worker fatigue in the safety management process could lead to significant safety outcome improvements in this sector [8, 9, 5, 10].

Fatigue has a physiologically detrimental impact. In the brain, fatigue compromises the functionality of the prefrontal cortex, affecting basic and complex cognitive functions that control the ability to concentrate and assimilate new information, plan, communicate, and react to stimuli [11, 12, 13, 14, 15, 16]. In the muscles, fatigue manifests itself by metabolic changes that decrease their functionality in terms of speed of move-

ment and strength, even affecting a person's balance [17]. Therefore, the potential impact of fatigue on accident causation becomes evident.

Nearly every respondent to the NSC's National Employee Survey on Fatigue[1] [5] has at least one risk factor for fatigue, and nearly all safety-critical industries report a higher incidence of multiple risk factors than all industries [18]. Although a conclusion cannot be drawn in a definable fashion that two or more risk factors multiply risk, it is common sense that the more risk factors individuals have, the higher the probability that their work quality, productivity, and safety will be affected. Minimizing factors that cause fatigue and implementing appropriate countermeasures to fatigue are ways to control health and safety risks in the workplace.

In June 2016, the Fatigue Initiative at the NSC was launched to document the impact of fatigue in the workplace as well as educate employers and provide resources to effectively manage fatigue risk in the workplace. In spring 2019, the Electric Power Research Institute (EPRI) partnered with NSC to investigate the impact of fatigue in the electric utility workplace, including construction, operation, and maintenance of electric power generating stations and electrical T&D infrastructure. This report summarizes the main aspects of a pilot study to help EPRI members obtain a better understanding of the causes of fatigue in the workplace, both from workplace factors and from employee habits on- and off-the-job. The project also sought to identify potential fatigue mitigation measures that would be appropriate for this industry sector.

2. Background on Fatigue

2.1. Causes and Consequences of Occupational Fatigue

A recent meta-analysis allowed for the identification of the most common causes and consequences of occupational fatigue among all industry workers [8]. Fatigue among workers is most commonly caused by sleep deprivation; environmental conditions such as noise, temperature, light, and vibration; muscular exertion; overtime and long working hours; incomplete recovery; poor social environment; heavy workload; and negative individual emotional predisposition [8].

Among these causes, sleep deprivation has traditionally been the most studied. Researchers have proven that not only does the quantity of sleep matter, but also the time of the day when this rest takes place because of the circadian rhythm of our bodies. Losing even 1 hour of sleep from the recommended 8 hours a day affects the recovery process and has immediate consequences, such as 10–30% reduction in cognitive ability. Sleeping 5 hours or less at night reduces cognitive abilities up to 40%, and this effect compounds with additional nights of reduced sleep. Furthermore, working during a low point in the circadian rhythm (between 3 a.m. and 6 a.m.) puts workers at a higher risk because of the natural tendency of the body to shut down functions during that time [19].

Some of the most renown industry catastrophes (for example, Exxon Valdez, Three Mile Island, and Chernobyl) occurred mainly due to human error during early morning hours [20]. Another meta-analysis of 27 observational studies estimated that up to 13% of workplace injuries could be attributed to fatigue caused by lack of sleep. Furthermore, the same meta-analysis indicated that workers with sleep disorders had a 1.62 times higher risk of being injured than those without sleep disorders [21].

Overtime and long working hours also impact fatigue. Working overtime (more than 40 hours a week) and working long hours can occur simultaneously or not. In any case, both induce fatigue by reducing the recovery time of workers by demanding additional hours of mental and muscular exertion and by further exposing workers to at-work fatigue stressors such as noise or vibration, among many others [8]. Folkard and Lombardi (2006) found that longer hours on task puts workers at a higher risk for injury, with the risk rising exponentially after 8 hours on task. For example, working 10 consecutive hours increases the injury rate by 13%, and working 12 hours increases this risk by up to 30%. Interestingly, the voluntary or involuntary character of overtime has an impact on the level of fatigue that arises from such work [8].

On the other hand, the principal consequences of worker fatigue include cognitive degradation, physical degradation, bad mood, error, and injuries. Therefore, fatigue in electric utility workers can exacerbate already elevated chances of incidents and injuries.

2.2. Fatigue Among Electric Utility Workers

Recently, the first fatigue empirical study among electric utility workers revealed some of the most common causes, consequences, identification, and management techniques experienced by utility company workers in the field [10]. Among the most preeminent causes of fatigue, workers identified extreme temperatures, long shifts, and lack of sleep. On a daily basis, many electric utility workers—such as overhead line workers—work exposed to the elements, even during weather inclemency. Underground workers work in confined spaces, such as manholes, where the temperature is approximately 10 degrees higher than ambient temperature. Consequently, extreme temperatures affect these workers more than workers in other trades. An added challenge to electric utility operations and maintenance is restoration of the T&D system due to weather inclemency and acts of God (emergency work), and other sources of equipment failure in the T&D system or in power plants, which often result in extended work periods and overtime. Rapid fluctuations in work demand are inherent to electrical utility workers, including those who work in power plants.

The most recognized consequences of fatigue as identified by utility company field workers were loss of attention and concentration as well as a slower ability to react and a slower work pace. These significant results underline the relevant impact of fatigue on safety and productivity for this sector of the industry [10]. Field workers already work in a very haz-

[1] NSC National Employee Survey was a probability-based study of 2,010 working adults. The survey sample was balanced according to U.S. Census figures of age, gender, ethnicity, and geographic region. Interviews were completed between February 17 and March 3, 2017.

ardous environment—exposed to energized lines, working at high elevation or below ground level, handling heavy equipment and chemicals, and even working near high-pressure steam lines. In addition, some utility workers also operate control centers for power plant operations and to monitor and operate the electric grid, and for these workers staying alert is also essential. Fatigue represents an additional risk factor by diminishing the ability of workers to stay alert and recognize and protect themselves from these hazards.

Regarding fatigue mitigation techniques, workers usually take a break and drink and eat something [10]. However, in most utility companies, there is no formal fatigue management program. Therefore, most workers have no formal training on fatigue causes and consequences and how to better manage fatigue. The current best standard for fatigue management consists of the development and implementation of a fatigue risk management system (FRMS).

Gander et al. (2011) defined a *fatigue risk management system* as "a scientifically based and flexible alternative to rigid work time limitations that provides a layered system of defense to minimize, as far as is reasonably practicable, the adverse effects of fatigue on workforce alertness and performance, and the safety risk that this represents." The principal layers of defense consist of 1) providing sufficient recovery time to workers, 2) assessing fitness for duty of workers, 3) implementing measures to prevent accidents when workers are fatigued, and 4) continuously improving by investigating fatigue-related factors that played a role during incidents. A multidisciplinary team with support from all organizational levels is required for the correct implementation of an FRMS.

The current study sought to shed additional light on these findings and produce results that can be used by industry practitioners to enhance the management of fatigue in the electric utility sector. To accomplish this objective, the researchers collected empirical data from workers in the field and utility company management to ensure ecological validity of the results. The following section describes in detail the procedure followed.

3. Study Methodology

The research team solicited volunteers from electric utility companies funding EPRI Program 62, Occupational Health and Safety. Five EPRI-member companies with good geographical representation from across the continental United States volunteered to participate in this study. Each member company had four individual locations (worksites) participate, for a total of 20 individual worksites and 1,375 employee responses. The employee response rates for the 20 sites ranged from 33% to 100%.

To achieve the objectives of the project, the researchers developed two questionnaires. The first, Operational Needs Assessment (see Appendix A), investigated workplace sources of fatigue (such as shift scheduling practices). The other questionnaire, Employee Survey (see Appendix B), identified employee habits that may exacerbate fatigue (such as sleep schedules). The information obtained from these surveys can potentially be used to develop a fatigue risk management system for the electric utility sector.

3.1. Operational Needs Assessment

The operational needs assessment was designed for use at the individual EPRI-member sites to identify hazards, calculate risk levels, and audit fatigue risk management countermeasures. The information for a characterization of fatigue factors within this industry can be used by the sites to create an action plan and develop policies, practices, procedures, programs, and/or training to better manage fatigue. The operational needs assessment was completed by a human resources manager and/or an operational leader at each site.

The operational needs assessment comprised three sections. Section One was designed to be a quick scan of fatigue hazards in the workplace through a series of Yes/No questions. This section asked questions about physical and mental work demands, general work scheduling, and environmental conditions that could affect ergonomics and fatigue. This section was most often completed by a site safety leader or workplace supervisor. Section One also included a special module that asked about schedules, hours, and shifts during unplanned power plant outages and operations restoration periods.

Section Two of the operational needs assessment determined the risk level of fatigue associated with the worksite by asking for data in two ways: scheduled work hours versus actual hours worked. This section also asked for data about the time of the day when near misses and incidents occurred.

Section Three continued the needs assessment with a short series of Yes/No questions pertaining to leadership commitment and initiatives for FRMSs that may already exist within the organization and that are employed at the site.

3.2. Employee Survey

The individuals who took part in the employee survey were employed at each of the 20 EPRI-member company sites. There were no formal requirements of individuals to participate in the employee survey other than working at a participating site.

The employee survey required about 10–15 minutes to complete online and was designed to gather information about on- and off-the-job factors that contribute to sleep health and energy levels that can act as sources of fatigue. Like the operational needs assessment, the employee survey comprised three sections.

Section One asked primarily about sleep health in terms of hours of sleep between consecutive workdays, the number of non-work hours between workdays, and the frequency and length of naps. This section also asked about employees' feelings of tiredness and fatigue while at work and which actions they take to prevent or mitigate fatigue.

Section Two mirrored the second section of the operational needs assessment by asking for scheduled work hours and actual hours worked. Regarding scheduling, Section Two also asked about the type of shifts that employees work, how many consecutive days they work, and whether and how many overtime hours they work. A special module of Section Two asked how many hours employees work during unplanned plant/unit outages and the aspects of their performance that are most affected when they are fatigued during restoration operations.

Section Three asked employees about their perceptions of the organization's safety culture when it comes to fatigue, specifically whether they believe that their employer sees fatigue as a safety issue or cares about the amount of rest they obtain outside of work. This section also asked about the quality of communication with their supervisor—for example, by inquiring about their level of fatigue while telling their supervisor that they need a break or that they're too tired to safely perform their job.

The questions for the employee survey along with an informed consent letter were uploaded to a third-party survey service, *QuestionPro™*. Contacts at the EPRI-member site distributed the individual survey links via e-mail to the employee sample. This process ensured that NSC investigators did not have access to employee e-mail addresses. Use of *QuestionPro™* ensured that no one at any EPRI-member site could trace who had or had not completed the employee survey. Individuals could cease their participation in the employee survey at any time.

The data collected from the employee survey were completely anonymous and were intended to help EPRI-member organizations understand the sources of fatigue in the workplace as well as the risk that fatigue may impose. To ensure confidentiality of the data, names of the participating companies were not and will not be disclosed to other EPRI members. In addition, any company identifiers of the reported raw data, analyzed data, and site reports have also been blinded to EPRI research staff.

4. Results and Analysis

The results that follow are organized by questionnaire. The operational needs assessment was completed by personnel from each of the 20 participant sites for a total of 36 assessments; the employee survey was completed by 1,375 workers collected between June and September 2019. Percentages of the following tables do not always add up to 100 because, in most cases, the participants could give more than one answer to a question or because the data presented in different rows were obtained from different questions.

4.1. Operational Needs Assessment

There were several risk factors for fatigue reported by at least 50% of the worksites on their completed operational needs assessments. These risk factors are categorized by work periods, rest periods, predictability of schedule, and circadian misalignment. The individual risk factors for fatigue considered in this study and their prevalence on the participating sites can be seen on Table 1.

The empirical results show that the electric utility sector can be characterized by its unpredictability of schedule. Nearly all worksites have variance in scheduling and require workers to be on-call or standby. As may be expected for the industry, the predictability of schedules for workers is greatly affected by storm restoration periods and unplanned outages, with 86% of worksites reporting this risk factor for fatigue (see Table 2).

Just over half of the worksites in the study use rotating or irregular shifts. This means that shifts can change according to a set schedule (rotating) or may vary from day-to-day and are unpredictable (irregular). Over half of worksites use long shifts of 12 hours or more, and nearly all worksites have mandatory and voluntary overtime policies.

Table 1. Risk Factors for Fatigue at Worksites

Fatigue Risk Factors	Percent of Worksites Reporting Risk Factor
Work periods	
Rotating or irregular shifts	56%
Long shifts (over 12 hours)	61%
Overtime	94%
Rest periods	
Short shift returns (less than 10 hours)	67%
No rest facilities available for breaks	53%
Predictability of schedule	
Variance in schedule	97%
On-call or standby	89%
Call-backs	72%
Storm restoration or unplanned outages	86%
Circadian misalignment	
Work between hours of 2 a.m. and 6 a.m.	89%

When it comes to rest periods, over 60% of worksites have short shift returns, which means that workers may have less than 10 hours from the end of one shift and the beginning of the next one. Furthermore, the commuting time of these workers fluctuates between 2 minutes and 2.5 hours, considerably reducing their available time for rest. After subtracting additional time commitments such as family responsibilities and leisure, the remaining time for sleep and rest may be too short to allow for a complete recovery. This routine has a compounding effect, generating an increasing level of fatigue on workers.

Almost all worksites (89%) reported the risk of circadian misalignment in workers by scheduling work between the hours of 2 a.m. and 6 a.m. These are the hours when humans are naturally at a low point in their levels of alertness and are at most risk for a fatigue-related incident.

During emergency work, most site managers require their employees to work more days than planned (97% of sites), which consequently reduces the number of days off (94% of sites) and/or extending the shift's length (90% of sites). These changes in the schedule directly impact the workers' sleep patterns.

Across all organizations in the study, the mean typical shift length during emergency restorations is 14.22 hours, and the mean typical length of a restoration period is 71 hours. Just over half (58%) of worksites have compensatory rest periods for workers after emergency restoration periods.

For components of a fatigue risk management system, most worksites (58%) had a diverse committee to manage fatigue in the workplace with representation from several departments such as operations, human resources, medical, data management, and the executive team. Regarding incentives to reduce fatigue, all worksites reported empowering their workers with "stop work" authority due to fatigue, and 91% reported having fitness-for-duty assessments (see Table 3).

Although almost all worksites reported that they communicate regularly to employees about fatigue as a hazard, only a minority provide education and training on fatigue to employees—and an even smaller percentage offers sleep disorder education to employees. Similarly, although most worksites have incident reporting systems, in general only 36% of worksites have a dedicated fatigue reporting system for employees.

Only about one quarter of the surveyed worksites have policies and practices for work hours (26%) and rest and recovery (29%) that go beyond state and federal laws that regulate schedules and breaks for employees. A slightly higher percentage of worksites (36%) reports having a fatigue risk management plan, but the majority of worksites do not have such a plan in place. Only 11% of worksites reported having a *continuous improvement process* for managing fatigue risk, which refers to a feedback loop involving the gathering of data to inform changes in policies, procedures, and management systems to mitigate fatigue risk.

4.2. Employee Survey

In the employee survey, workers answered questions about sleep, health, and habits. The majority of employees (87%) across all worksites answered that it is very important for them to get good sleep. One quarter of respondents said that they very often or always feel tired at work. On average, respondents said that they obtain 6.6 hours of sleep (median = 6.5; standard deviation = 1.33) between two consecutive workdays, which is slightly below the 8 hours recommended by sleep experts. Respondents obtain more sleep between two consecutive days off from work: an average of 7.8 hours (median = 8; standard deviation = 1.22).

For fatigue risk factors, the majority of employees reported that they at times work at night (61%), can have long weeks at work (73%), and put in overtime (83%). The vast majority of workers perform work during storm restoration periods and unplanned outages, which leads to unpredictability of schedule. Almost all employees (95% answering "often" or "always") perform repetitive and physically and mentally demanding tasks on a regular basis, and large portions of employees are regularly exposed to loud noise and extreme temperatures (see Table 4).

Employees also noted how their performance is affected during storm restorations and unplanned outages. The top three consequences noted by employees are long hours on-the-job (81% of respondents), lack of sleep (80%), and demands from continual workload (74%). The top three performance effects that employees reported during storm restoration operations were decision-making (72% of respondents) ability, situational awareness (71%), and problem-solving skills (70%). See Table 5.

In the employee survey, about half of employees agreed that their employer sees fatigue as a safety issue (54% in agreement) and that their employer encourages breaks (50%). Only about a third of employees agreed that their employer cares about how much rest they obtain outside of work (33%) and that their employer considers their ability to obtain sleep when scheduling shifts (28%). See Table 6.

Table 2. Consequences on Schedule of Storm Restoration Periods or Unplanned Outages

Consequences on Schedule	Percent of Worksites Reporting
More consecutive days of work	97%
More consecutive nights of work	71%
Extended work shifts	90%
Regular sleep pattern is disrupted	84%
Days off between shifts is reduced	94%

Table 3. Fatigue Risk Management Audit

Fatigue Risk Management System Components	Percent of Worksites with Components
Diverse committee	58%
Fatigue risk management plan	36%
Policies and practices	
Work hours policies/practices	26%
Rest and recovery policies/practices	29%
Incentives to reduce fatigue	
"Stop work" authority due to fatigue	100%
Fitness-for-duty assessments	91%
Weather policy	78%
Training and education	
Sleep disorder education	19%
Fatigue education and training	33%
Communication to employees	97%
Data-driven programs and continuous improvement	
Monitoring for fatigue risk	31%
Reporting system	36%
Incident reporting	89%
Continuous improvement	11%

Table 4. Risk Factors for Fatigue Among Employees

Fatigue Risk Factors	Percent and Number of Employees Reporting Risk Factor
Work periods	
Overtime	89% n = 951
Long weeks	78% n = 948
Ever work at night	73% n = 949
Long shifts (over 12 hours)	35% n = 432
Rotating or irregular shifts	33% n = 419
Rest periods	
Commute time (30 minutes+)	53% n = 636
Short sleep duration prior to work periods	34% n = 433
Caregiver	47% n = 588
Predictability of schedule	
Storm restoration or unplanned outages	99% n = 1126
Variance in schedule	78% n = 961
Environmental and job conditions	
Demanding tasks (physically, mentally, repetitive)	95% n = 1178
Extreme temperatures	54% n = 670
Loud noise	50% n = 624
Vibrations	39% n = 488
Poor lighting	35% n = 436

n indicates that the sample varies by question.

Table 5. Effects of Restoration Operations Among Employees

	Percent and Number of Employees Reporting
Consequences of Restoration Operations	
Long hours	81% n = 1123
Lack of sleep	80% n = 1107
Demands from continual workload	74% n = 1018
Physical exhaustion	73% n = 1003
Working at night	72% n = 996
Stress	46% n = 983
Environmental conditions	69% n = 943
Lack of proper nutrition	67% n = 924
Performance effects during restoration operations	
Decision-making ability	72% n = 996
Situational awareness	71% n = 977
Problem-solving skills	70% n = 969
Judgment	70% n = 963
Communication	69% n = 947

n indicates that the sample varies by question.

Table 6. Fatigue Safety Culture Perceptions Among Employees

	Percent and Number of Employees Agreeing
My employer sees fatigue (or being tired) as a safety issue	54% n = 747
My employer encourages breaks	50% n = 690
My work schedule allows me to get the proper rest I need to function safely on-the-job	42% n = 583
My employer cares about how much rest I get outside of work	33% n = 448
My employer considers my ability to get sleep when scheduling shifts	28% n = 391

n indicates that the sample varies by question.

4.3. Discussion

This study supports previous research that fatigue affects electric utility company workers daily and that its consequences can be pervasive. The hectic and unpredictable work demand of the power grid requires companies to satisfy abrupt increases of work demand with a limited and steady workforce. Consequently, electric utility leaders rely on significant overtime and schedule changes to guarantee the required level of service. This situation represents an unsustainable work model that exposes electric utility workers to cumulative and dangerous levels of fatigue.

The results of this study, which includes both T&D and power plant workers, are consistent with previous findings pertaining to T&D utility construction workers [9, 10] and provide additional evidence that extreme temperatures, noise, long shifts, overtime, and lack of sleep are the principal contributors to fatigue in this sector. In addition, this study also confirms that fatigue causes a decrease in situational awareness, decision-making ability, and problem-solving skills— among others—directly impacting workers' safety and productivity. These results suggest that enhanced management of fatigue in the electric utility sector could improve both safety and productivity.

There is a shared understanding among in-the-field electric utility workers and management of the importance of managing fatigue and the need for sufficient recovery as manifested by the percentages in Table 4-6. Nonetheless, among the companies studied in this project, fatigue safety culture has not yet fully evolved into formal fatigue management programs with specific fatigue mitigation policies. This can be seen by the disparity between the acknowledgment of an existing fatigue safety culture and the lesser percentage of sites with a formal fatigue management plan.

It is important to mention that most efforts to mitigate fatigue in this sector are carried out by health and safety; wellness; and construction, operations, and maintenance professionals who seek to make a difference and improve the current safety state of the sector. The existing regulatory framework does not specifically require the management of fatigue.

Occupational Safety and Health Administration (OSHA) standards for electrical work do not directly address the issue of fatigue. Nonetheless, employers are required by OSHA to provide a workplace free of recognizable hazards [24], and fatigue is certainly an important one.

Even the sites with a formal fatigue management plan (36%) did not present all the elements of an FRMS, indicating that there are still opportunities for improvement. The comprehensive management of fatigue through an FRMS involves the establishment of a dedicated multidisciplinary team with members from all levels of a company, allowing for the necessary input to recognize fatigue hazards and the required support to implement any potential managing action. In addition, an FRMS's effectiveness is enhanced by periodic updates and evaluations. In this way, the layers of defense against fatigue become more effective and resilient.

The electric utility sector employs a wide range of power delivery, power plant, customer service, office workers, and others who are subdivided into several categories according to their functions. For instance, line workers are subdivided into overhead workers, underground workers, substation workers, equipment operators, power plant workers, power plant operators, fuel technicians, tools technicians, and others. The results obtained in this study come from power delivery, power plant and other workers, and front-line supervisors; therefore, the conclusions and recommendations driven from these results are likely to be representative of these groups. A more comprehensive study is suggested.

An FRMS is unique to each company and worksite, and it should stipulate different fatigue management techniques for each of these subgroups according to their needs and fatigue risk factor exposure. For example, a power plant control room operator performs his or her work indoors—reviewing control and computer screens and interacting with plant operations and maintenance (O&M) staff—so the fatigue risk factors may be related to shift length, monotonous or repetitive tasks, level of light in the room, posture, and circadian rhythm. On the other hand, the fatigue risk factors affecting underground line crews may be related to working in confined spaces, noise, vibration, temperature, and shift length, among others. Therefore, fatigue management measures should address the needs of the groups to which they apply.

In general, office workers are exposed to a significantly lower safety risk, despite their level of fatigue, by working in a less hazardous environment than line crews or power plant operators or mechanics. Nonetheless, their failure to perform their work activities correctly also may have significant consequences on grid or power plant operations. In addition, these workers may manifest a lower level of fatigue because they have more predictable schedules. Consequently, an FRMS should primarily focus on developing measures for groups of workers with similar fatigue exposure operating conditions.

The following section presents numerous recommendations derived from the results of this study. These recommendations can be used by utility company leaders to set the bases of an FRMS. As highlighted in these results, customization by work groups results in the most effective FRMS.

According to the results obtained in this study, the correct development, implementation, and continuous use of an FRMS could not only improve the safety outcomes of a utility company, but also improve efficiency and revenue due to a less fatigued workforce.

5. Recommended Mitigation Measures

The recommendations for the participating companies and worksites participating in this study—and more generally applicable to the electric utility industry—have been organized along the five key components of a fatigue risk management system [25]: 1) education and training, 2) policies and practices, 3) shared responsibility, 4) fatigue mitigation, and 5) data-driven programs and continuous improvement.

The following recommendations are largely based on general tenets of optimal fatigue management approaches. The research team notes that the unique operating environment, scheduling requirements, and real-time customer service needs create different challenges in effective fatigue management, for example, in comparison to a three-shift manufacturing facility. An overarching recommendation from the research team is that EPRI Program 62 convene a fatigue management working group—ideally augmented with both industry-specific and external subject matter experts (SMEs), with full participation of electric utility SMEs—to identify specific actions and approaches that are practical to implement in light of the unique operating conditions of this sector. This working group should also be tasked to work with staff to identify new needs for fatigue management approaches that reflect the unique work conditions.

5.1. Education and Training

Fatigue Management Education

Fatigue management education can take on various forms, including in-person classroom sessions as part of a corporate wellness program; break room posters; or safety talks that raise awareness about the risks related to fatigue, drowsy driving, factors that contribute to fatigue, and how fatigue can be effectively managed. Awareness should be raised about increased fatigue risks during early morning hours and for the commute into work.

Sleep Health Education

Sleep health education, delivered through a corporate well-being program, is a relatively easy and effective way to provide information and raise awareness on the importance of good, healthy sleep to employees. Education can include the following:

- Fundamentals of sleep, including physiological sleep need and how the stages of sleep are linked to both physical and mental restoration
- The effects of lost sleep and fatigue on safety and effective performance when performing demanding tasks
- Awareness that adequate quality sleep along with regular exercise and proper nutrition are part of a healthy lifestyle
- How caffeine, alcohol, and nicotine use affect sleep
- How pain and other medications may impact sleep
- Strategies for better sleep, such as pre-sleep routines, limiting screen time, and relaxation techniques

- How our circadian rhythms influence our daily performance and alertness
- How practices such as journaling sleep habits and identifying barriers to proper sleep can enable individuals to develop personalized plans for improved sleep

Sleep Disorder Education and Screening

Untreated sleep disorders among employees may affect both organizational and individual health and safety performance—and ultimately productivity. Some organizations have found significant cost savings related to programs that address these issues in their workforce [26]. However, this approach needs to be implemented with caution, ensuring the anonymity of workers to prevent any sort of discrimination or preferential treatment. A way to make this possible is by providing employees with the opportunity to participate in a sleep study and receive medical attention through a third-party physician, eliminating any possible reporting back to the company but providing the service.

Educational efforts can include in-person classroom sessions as part of a corporate wellness program. Programs that include sleep disorder screening are effective at ensuring that employees understand their risk for a sleep disorder. Programs that include screening, treatment, and compliance monitoring have shown decreases in near-miss, accident, and injury rates as well as health care cost reductions.

Education on Drowsy Driving

Workers should be aware of the risks associated with drowsy driving. Raising awareness and promoting the effective use of strategies should be included in this effort.

5.2. Policies and Practices

The recommendations in this subsection are among the most challenging for this industry sector and reinforce the need for a collaborative effort to identify practical implementation strategies. These policies should be adapted to meet the needs of the electric utility sector considering the challenges unique to this sector. Electric utility and external SMEs could assist in this task.

Limits on On-Call Periods

Policies should be considered to minimize the use of on-call work periods and provide as much advance notice as possible when used. Potential examples could include limiting individuals to on-call work for two consecutive days or four times per week. Another example would be to ensure that workers receive additional paid compensatory rest time after completion of their on-call duties. Use of contract crews could augment utility staffing to provide greater flexibility in scheduling to facilitate implementation of this recommendation.

Safety-Sensitive Tasks

Workers who have been on duty 12 or more hours should take extra precautions and safeguards or minimize safety-sensitive tasks when possible. Advance planning for such tasks when possible can minimize fatigue-related risks after long hours on shift.

Overtime Policies

Companies should track workers' overtime and establish policies to prevent them from working overtime to the point of becoming dangerously fatigued. Additional precautions are encouraged during overtime (for example, provide extra breaks, double-check work, and monitor workers for fatigue symptoms).

Predictable Schedules

Policies that minimize scheduling variability should be encouraged, such as providing as much advance notice as possible so workers can best plan for rest and sleep during their time off. Stability in start times is especially important because variability in shift starts has been linked to increased human errors and risks.

Safe Transportation

An employee assistance program that provides fatigued workers with the option of safe transportation home, especially after extended or on-call work periods, should be considered.

5.3. Shared Responsibility

Employer Responsibility

Fatigue management is a shared responsibility between employers and employees, and there are specific actions each can take to manage fatigue and maintain a safe and healthy workplace. Employers can do the following:

- Ensure that employees have plenty of time off between shifts (at least 12 hours) to recover.
- Encourage employees to report fatigue-related concerns when present.
- Create systems to gather and review data and apply findings to improve processes.
- Educate employees on the causes and consequences of fatigue and how to identify fatigue symptoms.
- Get input from employees on fatigue hazards they experience and possible mitigation strategies.

Employee Responsibility

In addition to the actions that employers can take to manage fatigue among the workforce, employees should do the following:

- Report for work rested and fit for duty.
- Recognize their own personal limits.
- Report issues through appropriate mechanisms.
- Note the signs or symptoms of fatigue in coworkers and encourage taking action.
- Recognize fatigue as a hazard to promote a culture of safety.

5.4. Fatigue Mitigation

As with Subsection 5.2, the following recommendations are also among the most challenging for this industry sector and reinforce the need for a collaborative effort to identify practical implementation strategies.

Rest Breaks

Regular breaks during a work shift allow for both physical and mental restoration as well as recovery from fatigue stressors. Short, frequent breaks (for instance, 10–15 minutes) may be better for this than a single longer break mid-shift, giving employees a chance to clear their heads and feel refreshed when transitioning between tasks. A dedicated break room facility can enhance these benefits.

Workers in the field should be provided with a quiet environment to take breaks, isolated from the impact of weather and with healthy drinks and food to replenish lost calories and nutrients. When working at a location for a short period of time, these conditions may be met inside a company truck (equipped with working air conditioning and heater). When working on a location for more than one day, a mobile break room may be temporarily placed near the worksite to allow for adequate recovery during breaks. Such units should include restroom amenities.

Power Naps and Facilities to Sleep

Sleeping is the most effective way to recover strength and eliminate fatigue. Allowing for a nap of 20–30 minutes when necessary can improve the safety and productivity of workers. Longer naps (45 minutes to 1 hour) may not be as effective because they require a longer awakening period. In addition, when working double shifts, workers should have facilities at work to sleep several hours when possible. These facilities could also be used for workers to rest between consecutive shifts when these shifts take place too close together.

Rotating Tasks

Rotating tasks when possible can benefit employees as mental fatigue, strain from repetitive motion, and fatigue due to environmental conditions such as vibrations increase with time on task. Combined with regular short breaks, this can give employees a chance to refresh and re-energize with a new task. Rotating tasks may require additional training efforts, but the researchers see this as a feasible improvement given the well-rounded and extensive training of electric utility workers.

Efforts should be made to schedule tasks that are especially safety-sensitive earlier in the shift and avoid performing these activities when there is an increased likelihood of sleepiness, for example, between 3 a.m. and 6 a.m.

5.5. Data-Driven Programs and Continuous Improvement

Identifying and Mitigating Employee Fatigue

Technologies exist that will assess fitness for duty and the level of fatigue of workers. For example, the PC-PVT[2] offers a 5-minute reaction time test that can be easily administered with laptops. With the applications of such technologies, the regular testing of workers at the beginning of the shift could be performed, which would allow for an individualized baseline performance and, more importantly, for the objective assessment of fatigue. It is important to understand that this type of assessment should never be used to justify negative repercussions against a worker. On the contrary, this testing is used to recognize and reward workers who show up to work fit for duty. If so implemented, workers will agree with the assessment and voluntarily participate in the testing.

The research team acknowledges that applications of such technologies **may be impractical for a highly decentralized workforce, especially those operating in the field**. Therefore, one of the research recommendations in Section 6 pertains to the development of a practical, individual fatigue measurement approach—capable of being applied in a field setting, requiring little to no technology, and that is quick, validated, easy to perform, and accepted by workers. Some research suggests that measurement approaches (such as using gait, driver monitoring) may have the potential for fatigue screening in the highest risk groups.

If fatigue monitoring or measurement testing reveals that a specific worker or crew presents a higher level of fatigue than acceptable, field supervisors and managers could assign tasks in a way that minimizes the risk to these workers. Furthermore, enough recovery time could be given to these workers. An assessment could take place during these situations to determine the cause of this excessive level of fatigue, and measures to mitigate these causes should be implemented when possible. Similar checks later in the shift might be considered, depending on shift length and pattern.

Monitoring of Schedules

The constant monitoring of employees' schedules, rather than a post-analysis of reported work hours, would allow for the identification of fatigue risk factors—such as too many consecutive shifts—and for an intervention before an incident takes place. Furthermore, this practice could originate the creation of new schedules that contribute to a lower fatigue level among crews.

[2] *PC* refers to *personal computer*, and *PVT* is *psychomotor vigilance task testing*. As described by Maxim Y. Khitrov et al., PC-PVT software "consists of two logically separate applications, the 'Manager' and the 'Tester.' The Manager is used by the investigator to create and configure testing protocols, enter subject information, and view the collected data and analysis results. The Tester is used by the subject to perform a 5- or 10-min PVT session." Maxim Y. Khitrov et al., "PC-PVT: A platform for psychomotor vigilance task testing, analysis, and prediction." *Behav Res Methods*, 2014; 46(1): 140–147. doi: 10.3758/s13428-013-0339-9, PMCID: PMC3936124, PMID: 23709163.

Evaluating Shift Schedules for Possible Fatigue Risk
Fatigue models are available that can determine the level of fatigue of an individual based on his or her shift history. Simpler applications such as risk assessment checklists can be adapted to provide similar feedback. Either approach can be used proactively or reactively to determine whether mitigations are necessary for anticipated work or, combined with other feedback (such as assessments from workers and supervisors), to provide an evaluation of work completed for a past project—generating potential lessons learned and enabling better planning for future projects.

Fatigue Reporting Systems
Examples of anonymous fatigue reporting systems can be found in other industries, such as transportation. Policies then need to be in place to govern the review of raised issues.

Reporting and Investigating Incidents for Continuous Improvement
Incident reporting provides another data source for those managing fatigue risks to determine where and when fatigue risks exist and then formulate efforts to manage those risks. For instance, incidents may occur during overtime or on-call situations. Further analysis would be beneficial to better understand such incidents, such as after how many hours on duty or how many consecutive days of work, to fully inform fatigue management efforts.

Implementation of an FRMS
Initiating steps to form an FRMS starts with creating a fatigue committee with participation from different departments at all levels of the company. Representatives from human resources or staffing; medical, health, safety, and wellness professionals; upper and lower management; and workers should be part of this committee. The committee would be responsible for developing and implementing the necessary layers of defense against fatigue, including the following:

- Determining a process that will establish benchmarks based on initial data collected and allow for future improvements
- Reviewing safety data and reports
- Making recommendations based on trends in review materials for process improvements
- Surveying supervisors and employees for attitudes and issues with fatigue
- Generating materials that can be included in education/training efforts that provide feedback to the workforce and present potential lessons learned

6. Recommended Research

As noted, this study consisted of administering surveys to workers at 20 sites among five EPRI-member companies as well as the operational assessments for occupational health and safety leadership at each company. These five companies collectively spanned multiple climatic regions of the United States and included management and workers from T&D construction, operations, and maintenance; power plant O&M; grid and power plant control centers; and customer call centers.

The research team recommends these additional steps:

1. Convene a working group of EPRI members and external SMEs to review these findings and fatigue mitigation approaches, assess the applicability to electric utility operations and suggest practical adaptations. These suggested practical adaptations could then be implemented at one or more companies to ascertain the "on-the-ground" applicability and workability of the approaches.

2. Concurrent with Recommendation 1, EPRI should organize and conduct an industrywide workshop for shared learnings among electric utility industry health and safety practitioners as well as those from other industries. This workshop could include SMEs from academia and other organizations who could share research results. In addition, the workshop could identify additional research opportunities.

3. Identify individual measurement approaches to identify fatigue levels in the higher risk work groups that are quick, easy to use, practical, and valid to screen workers on-the-job. Individual fatigue factors are highly variable—both in general and in variance from day-to-day and within a work shift. Identifying and testing approaches will not be simple but is potentially an important tool to ultimately reduce fatigue-related injuries and improve productivity.

4. Explore the possibility of field research within these operations, gathering objective and subjective sleep and performance data to gain further insights into challenges these workers confront. These data could provide the basis for more focused fatigue management strategies specific to these operations.

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The following organizations, under contract to the Electric Power Research Institute (EPRI), prepared this report:

National Safety Council (NSC)
1121 Spring Lake Dr.
Itasca, IL 60143

Principal Investigators
E. Whitcomb
J. Inouye

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A Operational Needs Assessment

A.1 Scanning for Fatigue Hazards

Scheduling and Hours

1. Please describe the typical schedule/s used in this worksite by sub-trade.
   (Example: Overhead crews: 4 consecutive shifts of 12 hours and 2 days off. Two shifts every 24 hours starting/ending at 7 a.m. and 7 p.m.).

Sub-trade	Shift details

2. **Y / N** Does anyone consistently work between the hours of midnight and 6 a.m.? Consistently means at least 30% of their working hours.

3. **Y / N** Are workers scheduled for at least one day off per week?

4. **Y / N** Does the work schedule make it difficult for workers to consistently have at least two consecutive nights of sleep per week?

   4.1 If yes, how often do workers have two consecutive nights off work?
   ____ Weekly
   ____ Bi-weekly
   ____ Monthly
   ____ Every couple months
   ____ Quarterly
   ____ More than quarterly

5. **Y / N** Do work practices include on-call work?

   5.1 If yes, how often do workers have two consecutive nights off work?
   ____ Weekly
   ____ Bi-weekly
   ____ Monthly
   ____ Every couple months
   ____ Quarterly
   ____ More than quarterly

6. **Y / N** Do work practices include call-backs?

   6.1 If yes, how often do workers have two consecutive nights off work?
   ____ Weekly
   ____ Bi-weekly
   ____ Monthly
   ____ Every couple months
   ____ Quarterly
   ____ More than quarterly

7. **Y / N** Do work practices include sleepovers?

   7.1 If yes, how often do workers have two consecutive nights off work?
   ____ Weekly
   ____ Bi-weekly
   ____ Monthly
   ____ Every couple months
   ____ Quarterly
   ____ More than quarterly

8. **Y / N** Do actual work hours vary from planned schedules?

9. **Y / N** Does the work schedule involve rotating shifts?

   9.1. If yes, describe the rotating shifts:
   _____
   _____
   _____

10. **Y / N** Does anyone regularly work in excess of 12 hours a day, including overtime?

    10.1. If yes, what percentage of your worksite regularly works 12 or more consecutive hours? _____

11. **Y / N** Is the break between shifts less than 10 hours? For example, split shifts, quick shift changeovers.

12. **Y / N** Do workers have split shifts?

    12.1. If yes, what are the characteristics of these shifts?
    _____
    _____
    _____

13. **Y / N** Is work performed at low body clock times (between 2 a.m. and 6 a.m.)?

14. **Y / N** Does the Site Manager/Supervisor approve all unplanned work beyond 12 hours?

15. **Y / N** Are there suitable rest facilities provided for breaks during the shift?

16. **Y / N** Are rest arrangements in place for employees following their arrival on-site?

Environmental Conditions

17. **Y / N** Does anyone perform work in harsh or uncomfortable temperature conditions (for example, hot, humid, or cold)?

18. **Y / N** Do you have an inclement weather policy in place?

    18.1 If yes, what are the stipulations (for example, outdoor work activities will cease if the outside temperature is above 100°F or below 0°F)?
    _____
    _____

19. **Y / N** Does anyone work with plant or machinery that vibrates?

20. **Y / N** Is anyone consistently exposed to loud noise?

A.2 Determining Risk Level

Scheduled Versus Actual Hours

21. What is the average shift length? What is the range?
    a. Scheduled hours: Average: _____ Range: _____ to _____
    b. Actual hours worked: Average: _____ Range: _____ to _____

22. What is the average number of hours worked a week? What is the range?
    a. Scheduled hours: Average: _____ Range: _____ to _____
    b. Actual hours worked: Average: _____ Range: _____ to _____

23. What is the average number of consecutive shifts?
    a. Scheduled: Average: _____ Range: _____ to _____
    b. Actual: Average: _____ Range: _____ to _____

24. What was the longest shift worked in the past 30 days?
    a. Scheduled: Average: _____ Range: _____ to _____
    b. Actual: Average: _____ Range: _____ to _____

25. How long is the break between consecutive shifts?
    a. Scheduled: Average: _____ Range: _____ to _____
    b. Actual: Average: _____ Range: _____ to _____

26. For workers who work overtime, how many hours beyond 40 per week does the average worker put in? (*Overtime* is defined as work time beyond 40 hours a week.)
    _____ hours a week

27. **Y / N** Do any of your work team members work in storm restoration of the T&D system or unplanned power outages?

    27.1. If yes, how frequently?
    ____ Weekly
    ____ Bi-weekly
    ____ Monthly
    ____ Every couple months
    ____ Quarterly
    ____ More than quarterly

    27.2. If yes, what is the typical length of shift during these periods?
    _____

    27.3. If yes, what is the typical length of the service or operations restoration period?
    _____

Near Misses, Incident Reporting, and Investigation

28. What percentage of near misses or incidents occurred during a night shift (a shift between the hours of midnight and 6 a.m.) in the last year?
    _____

29. What percentage of near misses or incidents occurred during an early morning shift (a shift that starts prior to 7 a.m.) in the last year?
    _____

30. How many accidents with hospitalization have you had in the last five years?
    _____

31. How many accidents without hospitalization have you had in the last five years?

    _____

32. How many fatalities have you had in the past five years?

    _____

33. When do accidents occur? For example, during slow times, during emergency work, off work, going back home, and so on.

    _____
    _____
    _____

34. Do more accidents occur among a specific sub-trade?

    _____

A.3 Needs Assessment (FRMS Audit/Countermeasures)

Leadership Commitment

35. **Y / N** Does your organization have a diverse committee in place to manage fatigue in the workplace, including representation from operations, HR, medical, data managers, and executive team?

FRMS Audit

36. **Y / N** Does your organization have an FRMS in place?

    2.1 If yes, what are the stipulations of your FRMS regarding schedule length?

    _____
    _____

    2.2. If yes, what are the stipulations of your FRMS regarding rest and recovery time?

    _____
    _____

37. **Y / N** Does your organization regularly monitor for fatigue risk, such as reviewing overtime schedules?

38. **Y / N** Does your organization communicate about fatigue as a safety concern?

39. **Y / N** Do workers have "stop work" authority on the grounds of excessive fatigue? ("Stop work" authority is the ability to stop the work task at hand.)

40. **Y / N** Does your organization have a fatigue reporting system for employees?

41. **Y / N** Does your organization have a way to evaluate workers' fitness for duty?

42. **Y / N** Does your organization have incentives to promote less fatigue?

43. **Y / N** Does your organization have incentives to work overtime?

44. **Y / N** Does your organization have procedures to determine whether fatigue played a role in an incident?

45. **Y / N** Does your organization have fatigue management training and education for employees and management?

46. **Y / N** Does your organization provide sleep disorder information and management?

47. **Y / N** Does your organization have a continuous improvement process for managing fatigue risks?

B Employee Survey

B.1 Sleep Health and Fatigue

Today, we would like to learn more about your work life and how it may impact your sleeping habits. First, let's understand your bedtime routine and sleeping habits.

1. How important is it for you to get good sleep?
   a. Not at all important
   b. Slightly important
   c. Moderately important
   d. Important
   e. Very important

2. How much can sleep loss affect…

	Not at all	Very little	Somewhat	To a great extent
Physical health				
Mental health				
Job performance				
Family life				

3. How often do you…

	Never	Rarely	Sometimes	Very often	Always
Get enough sleep to feel your best the next day					
Feel tired at work					

4. How many hours do you usually sleep between two consecutive workdays?
   (Example: If you work Monday and Tuesday, how much sleep do you get after your Monday shift but prior to your Tuesday shift? Include time napping.)
   _____

5. How many hours do you usually sleep between two days off from work?
   (Example: If you have Saturday and Sunday off, how much sleep do you get on Saturday? Include time napping.)
   _____

6. How many hours do you usually sleep on your last night off work?
   (Example: If you have Saturday and Sunday off, how much sleep do you get on Sunday prior to your Monday shift? Include time napping.)
   _____

7. If you are routinely scheduled to work different shifts, how many hours of non-work time do you get between the last day of one shift and the beginning of the next shift?
   (Example: If your day shift rotation ends at 6 p.m. Monday and your night shift rotation starts at 6 p.m. Tuesday, you would answer 24 hours.)
   _____

8. If you work at night, how many hours do you typically sleep during the day, after your shift?
   _____

9. **Y / N** Does your employer allow naps to be taken at work?

10. If yes, are you encouraged to take naps at work?

11. Do you take naps at work?
    If so, how often?_____ For how long (minutes)? _____

12. How fatigued or tired do you feel…

	Not tired at all	Slightly tired	Moderately tired	Very tired
At the beginning of your shift?				
During your shift?				
At the end of your shift?				
During your last shift before your day off?				

13. How do you know when you are fatigued? (Mark all that apply)
    a. Yawning
    b. Heavy eyelids
    c. Nodding off
    d. Slower doing tasks
    e. Making more mistakes
    f. Harder to concentrate
    g. Moody
    h. Don't know/it's hard to tell
    i. Other: _____

14. How do you know when a coworker is fatigued?
    a. Yawning
    b. Droopy eyes
    c. Nodding off
    d. Slower doing tasks
    e. Making more mistakes
    f. Moody
    g. Don't know/it's hard to tell
    h. Other: _____

15. What do you do if you are fatigued? Select as many that apply.
    a. Take a quick break
    b. Tell my supervisor
    c. Drink or take caffeine
    d. Nap
    e. Nothing
    f. Other: _____

16. What do you do if your co-workers are fatigued? Select as many that apply.
    a. Encourage them to take a quick break
    b. Tell the supervisor
    c. Encourage them to drink or take caffeine
    d. Encourage them to nap
    e. Nothing
    f. Other: _____

17. What could you do differently to prevent fatigue? Select as many that apply.
    a. Get better sleep
    b. Nap before my shift
    c. Drink more caffeine
    d. Don't know
    e. Nothing
    f. Other: _____

18. Do you drink coffee before your shift? (A typical coffee mug can hold 8 oz.)
    If so, how much?_____oz__

19. Do you drink coffee during your shift? (A typical coffee mug can hold 8 oz.)
    If so, how much?_____oz__

20. Do you drink energy drinks before your shift? (A Red Bull® is 8.4 oz.)
    If so, how much_____oz

21. Do you drink energy drinks during your shift? (A Red Bull® is 8.4 oz.)
    If so, how much_____oz

B.2 Job Factors

22. What hours or shift do you typically work?
    a. Daytime hours/shift only
    b. Evening hours/shift only
    c. Night shift only
    d. Rotating shift (shifts that rotate or change according to a set schedule)
    e. Irregular shift (shifts that may vary day-to-day and are unpredictable or follow no set schedule)
    f. Other (specify)
    _____

23. How long is your scheduled workday or shift length?
    _____

24. How long is your actual, typical workday in hours?
    _____

25. How many hours are you scheduled to work a week?
    _____

26. How many hours do you actually work a week?
    _____

27. Is overtime voluntary or involuntary?

28. How many hours of overtime do you work in a typical week?

29. How many consecutive days do you work without a day off?

30. During storm restoration periods, unplanned plant/unit outages, or emergencies, how many consecutive hours do you work?

31. On average, how many hours do you get off from the end of your workday until you begin to work again? For example, if your workday ends at 5 p.m., and you begin work the next day at 8 a.m., your answer would be 15 hours. If your work schedule varies, please give your best estimate.
    _____

32. Roughly how many breaks, including lunch, do you take in a workday? By breaks, we mean any activity away from your work that lasts 10 minutes or longer.
    _____

Thinking about your regular job, about how often do you…

	Never	Rarely	Sometimes	Often	Always
33. Perform physically demanding tasks (such as heavy lifting, frequent movement, or on your feet)					
34. Perform mentally demanding tasks (such as monitoring, reading, scheduling, strategic development)					
35. Perform frequently repetitive tasks (such as driving long distances, assembling, or typing)					
36. Work with machinery that vibrates?					
37. Get exposed to loud noise?					
38. Work in poor lighting conditions?					
39. Work in high temperatures (above 80°F)?					
40. Work in low temperatures (below 30°F)?					

How much do the following conditions contribute to your fatigue or feelings of tiredness at work?

	Not at all	Very little	Somewhat	To a great extent
41. Physically demanding tasks				
42. Cognitively or mentally demanding tasks				
43. Repetitive tasks				
44. Vibrations				
45. Loud noise				
46. Poor lighting				
47. High temperatures				
48. Low temperatures				

49. During restoration operations or unplanned plant/unit outages, which factors are you most affected by? (Select up to three.)
    a. Long hours being awake
    b. Demands from continual workload
    c. Physical exhaustion
    d. Working at night
    e. Lack of sleep
    f. Environmental conditions
    g. Lack of proper nutrition
    h. Stress

50. When fatigued or tired during restoration operations or unplanned plant/unit outages, which aspects of your performance are most affected? (Select up to three.)
    a. Decision making
    b. Judgment
    c. Communication
    d. Problem solving
    e. Situational awareness

51. On average, how many minutes is your drive to work? If you don't drive, please write 0.
    _____

52. Do you have a second job?
    a. If yes, how many hours a week do you work there?

53. **Y / N** Do you have small children at home or someone who requires care?

B.3 Attitudes and Beliefs

How often do you feel…

	Never	Rarely	Sometimes	Often	Always
54. Pressured to work more hours?					
55. Pressured to skip or take fewer breaks during your shift?					
56. Your work schedule causes you to get less sleep than you need?					
57. Workplace safety is at risk due to your own tiredness?					
58. Your safety at work is at risk due to someone else's tiredness?					

59. If you had your preference, how long would you like your shift to be?
    _____

60. If you had your preference, how many consecutive days would you like to work?
    _____

61. **Y / N** Do you need more than two days off to recover?

Please rate your level of agreement with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
62. My employer sees fatigue (or being tired) as a safety issue.					
63. My employer encourages breaks.					
64. My employer cares about how much rest I get outside of work.					
65. My employer considers my ability to get sleep when scheduling shifts.					
66. My work schedule allows me to get the proper rest I need to function safely on-the-job.					

Please rate your level of agreement with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
67. I am not able to perform my job as well when I'm tired.					
68. I feel comfortable telling my supervisor I need a break.					
69. I feel comfortable telling my coworker they need a break.					
70. I feel comfortable telling my supervisor my coworker needs a break.					
71. I would not feel comfortable telling my supervisor I am too tired to safely perform my job.					

72. **Y / N** Have you ever been involved in an incident or accident at work where fatigue was a contributing factor?

73. **Y / N** Have you ever been involved in an incident or accident while driving where fatigue was a contributing factor?

Note

For further information about EPRI, call the EPRI Customer Assistance Center at 800.313.3774 or e-mail askepri@epri.com.

EPRI RESOURCES

Eric Bauman, *Principal Technical Leader and Program Manager, P62*
410.336.3918, ebauman@epri.com

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Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com