

# Tired at Work:

## How Fatigue Affects our Bodies



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## What is Fatigue?

Fatigue describes the feelings of tiredness, sleepiness, reduced energy and increased effort needed to perform tasks at a desired level. Fatigue affects people by making it difficult to think clearly and react quickly. In workplaces, fatigue decreases productivity and increases risk of injuries. While the signs may not be obvious, fatigue is a safety risk in the workplace.

It is important to understand the underlying causes of fatigue and how it negatively impacts the workplace. Identifying and addressing the causes of fatigue and implementing appropriate countermeasures can help ensure a safe working environment.

**Fatigue describes the feelings of tiredness, sleepiness, reduced energy and increased effort needed to perform tasks at a desired level.**

## What Causes Fatigue in the Workplace?

Research has identified many causes of workplace-related fatigue, both biological and environmental. Biological causes of fatigue are regulated by hormones in the body. Circadian rhythm misalignment and sleep deprivation are both biological causes of fatigue. Environmental causes often include job requirements, tedious tasks and organizational attitudes toward work schedules.

## Biological Causes of Fatigue

### Time of Day: How Circadian Misalignment Affects Fatigue

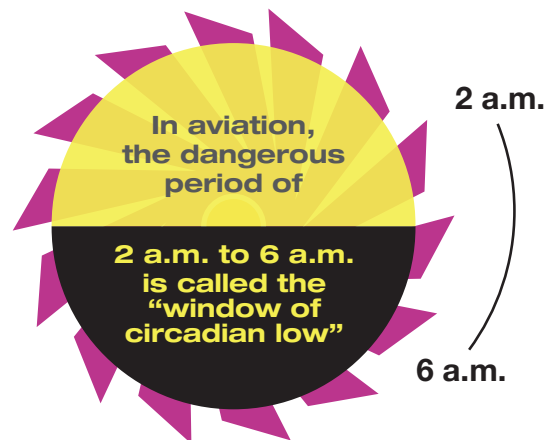
#### Nature vs. culture

Anyone who has been awake in the early morning hours knows that it is more difficult to be alert at 2 a.m. than at 2 p.m. This is due to circadian rhythm. Humans are biologically programmed to be asleep when it is dark and be alert during daylight hours. This drive is regulated by the release of hormones in our body, melatonin and cortisol. Melatonin is the key hormone that causes us to be sleepy. The body begins to release melatonin when the sun goes down and continues to release it until dawn. Cortisol, a hormone involved in many body functions such as metabolism, is also regulated by the time of day.<sup>1</sup> Cortisol levels are higher during the day and drop at night to allow for sleep. Individuals who need to be alert during nighttime and sleep during the day struggle against their own biology, called circadian misalignment.

**Due to the body's circadian rhythm, it is more difficult to be alert at 2 a.m. than 2 p.m.**

## Circadian rhythm — the body clock

Most people's circadian rhythm is on a predictable schedule. Melatonin begins secreting around 9 p.m. and deepest sleep happens around 2 a.m. Melatonin stops secreting around 7 a.m. and peak alertness occurs around 10 a.m. People who must work against their own circadian rhythm will find it difficult to perform during the late-night or early-morning hours. They will also find it difficult to get sleep during the daylight hours. Perkins (2001) concluded that people who sleep during the day receive up to four hours less sleep than those who sleep during the night.<sup>2</sup> The combination of circadian misalignment and sleep debt (the difference between needed and actual hours of sleep) can be a recipe for disaster.



Laboratory studies have shown that when the sleep cycle is out of sync with circadian rhythm, many health problems arise: lower glucose metabolism, cardiovascular problems, and impaired attention, mood, learning and thinking.<sup>3</sup>



## Employees most at risk for circadian misalignment.

Many jobs in the U.S. simply do not stop when the sun goes down. Shift workers are most at risk, including those on evening shifts, early morning or night shifts, rotating shifts or irregular shifts. Those who drive during nighttime or early morning hours are also vulnerable to fatigue and fatigue-related risks.

**Shift workers.** Shift workers are highly vulnerable to fatigue and fatigue-related risks. Shiftwork is defined as working outside of the daylight hours of 7 a.m. to 6 p.m.<sup>4</sup> Shift workers often work when their bodies naturally want to be asleep, making them vulnerable to fatigue from circadian rhythm misalignment. In addition, shift workers often have trouble getting proper sleep in their downtime, leading to a decrease in quantity and quality of sleep. This results in sleep deprivation and the further accumulation of fatigue.<sup>3-12</sup>

**Transportation professionals.** Employees who transport goods or passengers can be vulnerable to fatigue and the consequences of it. Drowsy driving is the act of operating a vehicle when tired or less than fully alert. Many studies have demonstrated an increase in traffic crashes during late night or early morning hours, when drivers must fight to stay alert.<sup>13-17</sup>

**Aging workforce.** Age also plays a role in the ability to adapt to a night shift schedule. Some studies show that people over 40 years old have a harder time adjusting their circadian rhythm.<sup>18-23</sup>

### Those most at risk include:

- Shift workers
- Medical staff
- Emergency responders
- Transportation professionals like truck drivers and pilots
- Military personnel
- Anyone over 40 years old

### Sleep Deprivation: A Major Cause of Fatigue

#### America: land of the free, home of the fatigued

Many people live and work in an environment where sleep loss is an indicator of being a hard-working and dedicated employee. For example, employees may feel obligated to answer emails at all hours, medical residents may feel pressured to skip rest to take care of patients, workers may accept extra hours after a regular shift and regardless of occupation, too many people are engaging with their phone late at night which can keep one awake. Those who choose to forego sleep for other activities are likely to suffer the debilitating effects of sleep deprivation.

#### A workforce running on empty

Experts recommend adults get at least seven hours of sleep every day<sup>24, 25</sup> but a recent National Safety Council

survey found 43% of working Americans are not getting enough sleep.<sup>26</sup>

**A recent survey ([nsc.org/FatigueSurvey](https://www.nsc.org/FatigueSurvey)) conducted by the National Safety Council found that 43% of American employees reported sleeping less than 7 hours every day.**

### Sleep disorders affect millions

While some people may choose to forego sleep for other activities, others are struggling with sleep problems. Sleep disorders can decrease both the quantity and quality of sleep, leading to fatigue.<sup>27</sup> Kessler and colleagues found that about one in four Americans suffer from chronic insomnia, a sleep disorder that affects a person's ability to fall asleep or stay asleep.<sup>28</sup> Obstructive sleep apnea (OSA) is a common sleep disorder that affects people by blocking the airway during sleep, often identified by loud snoring or gasping. The American Academy of Sleep Medicine estimates that 25 million Americans suffer from OSA.<sup>29</sup> Other health problems, such as asthma, osteoarthritis and restless legs syndrome also prevent people from getting an adequate night's rest.<sup>27, 30-36</sup>



**Insomnia and obstructive sleep apnea prevent millions of Americans from getting proper rest and puts them at risk for chronic diseases and even death.**

**For more information on sleep disorders, visit [nsc.org/SleepDisorders](https://www.nsc.org/SleepDisorders)**

# NSC FATIGUE Cost Calculator

## Sleep disorders and sleep deficiency are expensive for employers.

Find out how much sleep disorders are costing your workplace with the National Safety Council Fatigue Cost Calculator. [nsc.org/tiredatwork](https://nsc.org/tiredatwork)

### Sleep debt: paying your ZZZs

Adults need at least seven hours of sleep every day. If adults do not get their minimum of seven hours of sleep, they fall into sleep debt. Sleep debt has to be repaid quickly, or sleep deprivation will set in.



### Continuous time awake takes a toll, too

Another key factor to consider is time awake. As soon as people wake up, their energy levels begin to decline and their sleep debt rises.<sup>37-45</sup> Fatigue accumulates as the day goes on. Research has shown that performance begins to degrade after 16 hours of being awake.<sup>46</sup>

Fatigue also accumulates in those who work long hours because they often do not have enough time to take care of personal responsibilities and prioritize sleep. Those who work more than 48 hours per week are more likely to suffer from short sleep duration, poor sleep quality and insomnia.<sup>47</sup>

People should avoid performing safety-sensitive tasks, especially driving, if they have been awake for 16 or more hours.

## Environmental Causes of Fatigue

### Time-On-Task Fatigue

Environmental causes of fatigue are often the result of one's tasks. Time-on-task fatigue is one example. Individuals will experience fatigue the longer they conduct a single task. There are three types of time-on-task fatigue that manifest themselves as mental tiredness, sleepiness or muscle tiredness.

### Mentally exhausting tasks are physically draining

The ability to remain focused on a simple task for an extended period of time is limited. If the task demands constant attention, reaction or vigilance, people find themselves having to exert an increasing amount of effort to maintain the same performance over time.<sup>48-50</sup> This is called high workload time-on-task fatigue. The longer people are required to do the task, the more fatigued they will get. High workload time-on-task fatigue can be seen with baggage screeners, quality control workers, and those who work on assembly lines.

### Tedious tasks unmask sleepiness

On the opposite spectrum is low workload time-on-task fatigue. This describes tasks that are tedious, unstimulating and monotonous. Examples include highway driving and monitoring tasks such as control rooms. The longer a person performs an unstimulating task, the more difficult it becomes to hold attention to the task. Low workload time-on-task fatigue can also unmask underlying sleepiness. Employees conducting these types of tasks who are also sleep deprived and/or working at circadian lows are at a higher risk of safety incidents. Drivers get impaired by fatigue faster than many realize. Research shows performance decreases in drivers after 90 minutes of driving.<sup>51</sup>

### Ergonomics affect fatigue on the job

Repetitive motion time-on-task fatigue describes activities that are done repetitively over extended periods of time, causing muscle fatigue. Examples include data entry and assembly work.

## Types of time-on-task fatigue

### High work load

Cognitively demanding tasks that require constant attention, reaction or vigilance

### Low work load

Low stimulation, monotonous tasks that unmask underlying sleepiness

### Repetitive motion

Tasks that involve prolonged repetition of specific muscle groups

## Job and Organizational Factors

Job factors such as experience level, poor lighting, air quality and noise level can introduce or add to an employee's fatigue. Also, organizational factors such as culture, practices and policies can play a significant role in fatigue.

### The job itself may contribute to fatigue

Some jobs are more prone to inducing fatigue than others. The type of task employees do can affect their level of fatigue. As described earlier, employees that perform low-or high-workload tasks are subject to time-on-task fatigue.

Job-related fatigue can also differ from employee to employee. Employees' level of experience with the task, and how physically or mentally demanding the task is, can affect their risk of fatigue. A rookie baggage inspector may find it more difficult to remain vigilant than a veteran. Experienced long-haul truckers may be more familiar with their limitations and avoid falling victim to drowsy driving, unlike their less-experienced counterparts.

### Worksite environment can invite fatigue

Environment has an effect on a person's ability to be awake and alert. Research has shown that employees who are exposed to loud noises over an extended period of time are more likely to become fatigued.<sup>52-59</sup> The air quality of the worksite can also contribute to an employee's level of fatigue.<sup>60-63</sup> However, one of the greatest environmental factors in workplace fatigue is lighting. Employees who are exposed to bright lighting have been shown to be more alert and have less fatigue.<sup>64,65</sup>

### Shift scheduling practices

Shift scheduling practices can play a significant role in employee fatigue. The number of hours on shift, the frequency and length of rest breaks, the time of day of the shift, the direction and frequency of shift rotations, and even the number of hours off between shifts will affect an employee's level of fatigue.

## Shiftwork: Challenges and Managing Risks

### Did you know?

The risk of injury on the night shift is 30% higher compared to the day shift.

Both employers and employees can take steps to manage the risks. Employers can implement forward rotating shift schedules that optimize time off between shifts. Employees can make sleep a priority and take a 2-hour nap prior to the start of a night shift.

## Organizational factors play a role in fatigue

The management of an organization can have a significant impact on employee fatigue. The organizational culture, especially safety culture, can play a big role. Does the organization see fatigue as a safety risk? Organizations that understand the importance of fatigue in safety are more likely to have policies and practices that effectively manage fatigue in the workplace.

Does the organization educate employees on fatigue and the importance of good sleep? A comprehensive safety management system should include components that manage fatigue risk, often called a fatigue risk management system.



**NSC surveyed working Americans on their risk factors for fatigue in the workplace. Nearly every respondent reported at least one of the following risk factors:**

- **Shiftwork** (night, early morning, rotating or irregular shifts)
- **Long shifts**
- **Long weeks**
- **No rest breaks**
- **Quick shift returns**
- **Sleep deficiency**
- **High-risk hours** (working during the nighttime or early morning, even occasionally)
- **Physically or mentally demanding jobs**
- **Long commutes**

**For more information on risk factors visit [nsc.org/FatigueSurvey](https://nsc.org/FatigueSurvey)**

## Fatigue's perfect storm – a lesson from a National Transportation Safety Board investigation<sup>66</sup>

In June 2014, a long haul trucker drove 12 hours, overnight, to begin a 14-hour shift. At the tail end of his 14-hour shift, and after 25 hours of straight driving, he failed to yield to traffic in a construction zone and plowed into the back of a passenger van at roughly 65 mph. This crash occurred around 1 a.m.

One passenger was fatally injured. Three others, including comedian Tracy Morgan, sustained life-threatening injuries.

### The trucker was suffering from three causes of fatigue:

- Sleep deprivation due to not having slept in 28 hours
- Time-on-task fatigue because he had been driving for 25 hours
- Circadian misalignment performance deficits since the crash occurred at 1 a.m.

## Effects of Fatigue


### What happens when employees are fatigued?

Fatigue caused by either biological or environmental factors has a myriad of detrimental effects, often building on and compounding one another. When employees are fatigued, first they will experience a decrease in their ability to perform basic cognitive functions, which will result in decreases in a number of vital activities such as attention, vigilance and memory. Fatigued individuals performing their jobs with these cognitive deficits will become less productive and increase their risk of a safety incident. In the longer term, fatigued employees will become more at risk for health problems such as mood disorders and chronic diseases. Finally, research has demonstrated that fatigued individuals are an economic strain to themselves, employers and society due to decreased productivity, absenteeism, increased risk of safety incidents and increased illness.

### Cognitive Performance Decreases

Most people know what it feels like to do a complicated task when they are tired. They may not realize that fatigue was likely affecting their brain long before they even noticed. In fact, humans are notorious for being unable to reliably determine how tired they are.<sup>46, 67, 68</sup> One study found that a single night of sleep deprivation decreased cognitive performance by 30%.<sup>69</sup> Another study showed that performance deficits are observed in as little as 16 hours of time awake.<sup>46</sup> Those struggling with sleep loss may not realize how quickly sleep debt occurs. People who lose only two or three hours of sleep each night show significant decreases in cognitive performance.<sup>46, 70</sup> When a person becomes fatigued, a number of cognitive functions begin to decline. Most importantly for employees, fatigue causes huge declines in attention,<sup>1, 71-75</sup> vigilance<sup>1, 13, 70, 71, 73, 76-80</sup> and memory performance.<sup>1, 73, 74, 75, 81-84</sup> With all of the cognitive performance decreases occurring when a person is fatigued, it is obvious that fatigue directly contributes to decreased productivity and increases safety risk.

## Cognitive functions impaired by fatigue



Attention, vigilance, memory performance, concentration, performance speed, reaction time, executive function, psychomotor activity, alertness, accuracy, mathematical calculation and judgment

With the compounding of sleep loss and circadian misalignment, studies have shown that night shift workers have slower response speed, decreased attention, and lower accuracy levels in comparison to day shift workers.<sup>1</sup>

### What's riskier: a tired employee or an intoxicated one?

Supervisors might say they would rather have an employee show up tired than intoxicated, but numerous studies have shown that the cognitive performance of the two are very similar.<sup>73</sup> In fact, some studies show that a tired employee is more impaired than an intoxicated employee. A person who has lost two hours of sleep from their normal eight-hour sleep routine will perform similarly to a person who consumed two to three beers. Therefore, a tired employee is just as risky as an intoxicated employee.

#### Can sleep loss mimic alcohol intoxication?

Roehrs and colleagues (2003) found that a person who loses two hours of sleep from a normal eight-hour sleep schedule performs similarly to someone who consumed three beers.

### Work performance suffers

As employees become fatigued and begin to experience decreases in cognitive performance, their work performance, including productivity, suffers.<sup>41, 42, 45, 74, 85</sup> Employees who are struggling to pay attention, slow to process information, or having trouble remembering basic work tasks are not as efficient as employees who are alert and energized. One study found productivity decreases up to 6% for employees who suffer from sleeping disorders.<sup>74</sup> Another study demonstrated that the U.S. loses \$136.4 billion annually in productivity due to employee fatigue.<sup>86</sup>



One study found productivity decreases up to 6% for employees who suffer from sleep disorders.<sup>87</sup>

### Safety incidents and injuries

The same cognitive deficits that affect work performance also affect safety performance. Employees in a fatigued state are more likely to make safety-critical errors, resulting in injuries.<sup>1, 88-93</sup> The National Transportation Safety Board (NTSB), which investigates major accidents in the U.S., has confirmed the association between fatigue and workplace safety incidents. NTSB has found fatigue to be a probable cause, contributing factor or a finding in 20% of their crash investigations.<sup>94</sup>



Sleeping for safety: 13% of workplace injuries can be attributed to sleep problems<sup>84</sup>

### Night shifts carry risks

Numerous studies have shown a higher safety risk among night shift workers compared to those on the day shift.<sup>15, 88-93</sup> One study found a nearly 30% increased risk of safety incidents on night shifts compared to morning shifts.<sup>90</sup> Another study found night shift workers were three times more likely to be injured in a workplace incident compared to day shift workers.<sup>91</sup>



### Effects of long shifts and overtime

Research shows safety risks increase with shift duration and number of hours worked per week.<sup>42, 90, 92, 95, 96, 97</sup> While many factors come into play, such as job type, successive shifts, time of day and how much time off between shifts, expert consensus is the more hours an employee works, the higher the risk. Employees on long shifts or on overtime are subjected to several causes of workplace fatigue. Long shifts can introduce time-on-task fatigue, especially if the tasks are repetitive, cognitively or physically demanding. Also, long shifts and overtime can overlap into the circadian sleep periods. Finally, employees who work long hours may find sleep takes a lower priority, especially if their overtime requires quick shift returns. A long shift can quickly become risky under certain circumstances. One study demonstrated a two-fold increase in safety risk in a 12-hour shift compared to an 8-hour shift.<sup>92</sup>

### Driving while fatigued: perils of drowsy driving

Most researchers agree that fatigue is often a contributing factor to traffic crashes.<sup>5, 14, 17, 80, 93, 95, 98-108</sup> It is estimated that 21% of all fatal crashes in the U.S. involve a drowsy driver — that's more than 6,000 fatal crashes every year.<sup>111</sup> It may be shocking to hear that one in three people have admitted to falling asleep while driving.<sup>110</sup> Fatigued drivers are often inattentive and slow to react.

**More than 6,000 fatal crashes a year involve a drowsy driver.**

### Preventing Drowsy Driving

The National Sleep Foundation suggest drivers get adequate sleep, seven to nine hours every day, schedule rest breaks every 100 miles or two hours, share the drive with a travel companion, and avoid alcohol and sedating medications. If a driver feels drowsy, NSF suggests he or she stop driving, take a 20-minute nap and drink a caffeinated beverage.<sup>111</sup>

### The High Cost of Fatigue

Fatigue is expensive. One researcher estimates that sleep deficiency leads to \$410 billion in societal costs.<sup>112</sup> A typical employer with 1,000 employees can expect to lose more than \$1 million each year to fatigue: \$272,000 due to absenteeism and \$776,000 due to presenteeism (being present at work but not fully functioning). An additional \$536,000 in healthcare costs could be avoided with optimization of sleep health.<sup>113</sup>

**Want to know how much fatigue is costing your workplace? Use the Fatigue Cost Calculator at [nsc.org/tiredatwork](https://nsc.org/tiredatwork).**

### Tired employees are less productive

Fatigue causes impairment of many basic cognitive functions such as alertness, concentration, accuracy, short-term memory and decision making. It can also result in physical impairments such as decreased reaction time and lower performance speeds. Psychomotor skills, which combine both cognitive and physical functions, are also impaired by fatigue — for example, coordination and balance.<sup>1, 13, 42, 70, 72, 73, 78, 79, 93</sup> Declining work performance from fatigue has been observed in those working night or rotating shifts; working overtime, long hours or sustained time on task; and employees with sleeping problems such as insomnia or untreated obstructive sleep apnea.<sup>1, 21, 42, 74, 97, 114</sup> Employee productivity losses up to 6% have been reported, depending on level of tiredness or sleepiness, and fatigue-related decreases in productivity can cost employers upwards of \$3,000 per employee annually.<sup>74</sup>





### The high costs of absenteeism and presenteeism

Absenteeism, the number of hours scheduled but not worked, costs over \$225 billion annually in the U.S. This means that employers are losing approximately \$1,685 per employee per year.<sup>115</sup> Rates of absenteeism are influenced by physical and mental health, occupational demands, stress, age, and importantly, sleep health. Absenteeism increases by 202% among those who work at night,<sup>116</sup> increasing per-employee costs for night-shift workers by \$1,719.

Presenteeism, the difference between actual work performance and possible performance, is also affected by fatigue and sleep deprivation. Compared to people who get sufficient sleep, people who average less than six hours of sleep each night lose six full work days of productivity each year, while those who sleep an average of six to seven hours lose 3.7 work days annually.<sup>117</sup>

### Untreated sleep disorders increase costs even more

Insomnia, obstructive sleep apnea (OSA), and restless legs syndrome are all contributors to sleep deprivation and fatigue. Individuals with sleeping disorders are more likely to be involved in workplace safety incidents.<sup>9, 85, 87, 108, 118</sup>

Chronic insomnia is defined as a recurring experience of not being able to fall asleep, waking up frequently after falling asleep, or the inability to fall back to sleep. Individuals with insomnia do not feel refreshed upon awakening and are often tired during the day, with diminished mental and physical performance.<sup>119</sup> Approximately 23% of working Americans suffer from insomnia, and it may be responsible for over \$63 billion in absenteeism and presenteeism.<sup>28</sup>

OSA occurs when a person's airway becomes partially or completely blocked many times during sleep, and he or she must repeatedly wake to reopen the airway. Because OSA sufferers typically do not gain full consciousness when they wake after episodes of not breathing, they often do not know the cause of their sleepiness and/or fatigue. Mild OSA affects 34% of men and 17% of women; moderate to severe OSA affects 13% of men and 6% of women.<sup>120</sup>

People with restless legs syndrome (RLS) experience uncomfortable sensations in their legs when they are attempting to fall asleep. The discomfort is improved by movement of the legs. RLS occurs to some degree in approximately 10% of the population. The prevalence increases with age and is more common among women.<sup>121, 122</sup>

## Health Consequences

People who are sleep deprived, and those who work non-daylight hour shifts or long hours, are at higher risk of vehicle crashes, obesity, psychological disorders such as anxiety and depression, musculoskeletal disorders, reproductive problems, diminished immune response and numerous chronic diseases including hypertension, cardiovascular disease, gastrointestinal disease, cancer and diabetes.<sup>2, 41, 123</sup>

## What Employers Can Do

### Educate employees on sleep health

Occupationally based sleep health education and sleep disorder screening programs have been shown to reduce the costs of fatigue by improving the sleep, performance, health and safety of the workforce.<sup>124</sup> These programs are often delivered through either in-person expert-led sessions, a train-the-trainer type model, or online. One study found that all approaches had positive results, though each approach had strengths and weaknesses.<sup>125</sup> The expert-led approach resulted in the greatest improvement in knowledge, but may be logistically difficult and costly. Participation was generally lower in the online group, but it may be the most cost-effective approach for some organizations. Employers should consider implementing the approach that would most benefit their own workforce.

### Ask supervisors to address employee fatigue

The signs of fatigue are not always obvious to the people who are suffering from it. Supervisors are often the first to notice when employees' productivity is decreasing, or their physical or mental performance is suffering. Supervisors can address the causes and effects of fatigue at team meetings to ensure employees know that fatigue is an important issue to the organization. In addition, they can schedule rotating shifts so employees always move forward on the clock, reducing circadian rhythm adjustment time.

### Support employee screenings and treatment for sleep disorders

Many companies support employee wellness through annual wellness screenings at work or through primary care physicians. Employers can ask their health care plan provider to include questions about sleep health in wellness screenings, and they may also consider adding sleep disorder study and treatment to their health care plans.

By letting employees know that fatigue is a major concern for their health, safety and success on the job, employers can control costs, reduce safety incidents and contribute to a healthier workforce. Employers are urged to use the National Safety Council Fatigue Calculator to find out the impact of fatigue on the bottom line.



# NSC FATIGUE Cost Calculator

Real Costs of Fatigue  
in the Workplace  
[nsc.org/TiredatWork](https://nsc.org/TiredatWork)

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