The New Paradigm for Managing Workforce Safety: Psychomotor Vigilance Testing

PISON®

Keeping a Safe Workforce Environment

Imagine the workforce you manage is just about to begin a new shift in the warehouse or head out on the road: ***Is everyone fully alert and ready to work?***

How you answer this question has serious injury and even life-and-death consequences for companies that operate transportation vehicles (e.g., trucks, aircraft, boats, and trains), heavy equipment, or industrial machinery. When employees aren't fit to work, you risk their safety. You also expose your company to risks from harm to the general public and property.

Despite regulated safety measures and heightened awareness of the need for workforce safety, accidents involving heavy machinery, vehicles, and construction equipment continue to increase. Many accidents occur because employees are impaired due to either fatigue or the use of alcohol or drugs.

The cost of accidents is significant and includes not only direct costs, such as repairs to damaged vehicles and property, worker compensation payments, legal fees, and medical expenses, but also indirect costs, such as fines, higher insurance premiums, fees associated with the investigation and corrective measures, damage to the company's reputation, lost revenue, and lost productivity.

Indeed, the cost of a fatal truck accident is estimated to be $3.6 million or more per crash.[7] The costs of severe aviation accidents are even higher—estimated at between $111 and $124 million and resulting in 18 to 20 fatalities every two years.[8]

Managing human factors remains a major risk for employers because traditional methods for determining if someone is fit for work, such as periodic drug screening or schedule management tools, are inaccurate or ineffective. Operations managers and safety officers simply can't be sure if they

Workforce Accidents On the Rise

- Injury-causing truck crashes increased 5.7% from 2016 to 2022.[1]
- Fatal work injuries increased 15% from 2013 to 2023.[2]

The Impact of Drugs, Alcohol and Fatigue

- Employees using drugs or alcohol contribute to 65 percent of on-the-job accidents.[3]
- 67% of truck drivers who die in accidents test positive for drugs or alcohol.[4]
- Fatigue is a contributing factor in 13 percent of commercial motor vehicle crashes.[5]
- Aircraft crews commit 40% more errors after being awake for 13 hours.[6]

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[1] National Safety Council. 2024. The involvement rate in injury-related crashes per 100 million large-truck miles driven.

[2] U.S. Bureau of Labor Statistics. December 2024.

[3] U.S. Department of Labor.

[4] D.J. Crouch, et al. November 1993. The prevalence of drugs and alcohol in fatally injured truck drivers. Journal of Forensic Science. 38(6):1342-53.

[5] U.S. Department of Transportation Federal Motor Carrier Safety Administration. 2007. The Large Truck Crash Causation Study. Publication No. FMCSA-RRA-07-017. Table 2. Washington, D.C.

[6] National Transportation Safety Board. January, 1994. A Review of Flightcrew-Involved Major Accidents of U.S. Major Aircarriers, 1978 through 1990. Safety Study NTBS/SS-94/01.

[7] Federal Motor Carrier Safety Administration [Internet]. Accessed December 29, 2024.

[8] Joel Huesler and Eric Strobl. May 2023. Predicting the Number of Fatalities in Extreme Civil Aviation Accidents. Journal of Air Transportation. 31(487):1-11.

are running the risk of a serious accident. In this white paper, we explore the use of a psychomotor vigilance test (PVT), a form of reaction time test, as a means of quantifying worker readiness and more accurately evaluating humans performance risk.

Why Traditional Methods to Monitor Workforce Safety Fall Short

Determining if a person is ready to go before they operate a vehicle, machine, or piece of heavy equipment generally involves three traditional methods:

- Conducting periodic, random testing (for drug/alcohol use),
- Monitoring the amount of time worked to reduce the risk of fatigue, and
- In some cases, monitoring sleep habits either by having the worker self-report their sleep hours or by providing the worker with a sleep tracking device to ensure they are getting enough sleep and recovery (for fatigue management).

These approaches fall short for multiple reasons:

Invasion of Privacy
Testing for drug use goes beyond determining whether a person is fit to do their job and exposes specific private behaviors. Companies that implement mandatory workforce drug testing may experience a decrease in employee morale and productivity. Similarly, monitoring an employee's sleep (whether self-reported or measured with a tracking device) relies on the employee to reveal personal behaviors that take place during their personal time.

Indirect Measurements
While striving to ensure a person's fitness to work, some companies monitor only tangential factors, such as heart rates, work schedules, or sleep, as indirect ways to assess fatigue. Heart rate, however, is not a reliable indicator because its applicability varies based on individual factors. Likewise, hours worked and hours slept ignore the impact of factors that affect a person's ability to safely work. For example, a worker could be under the maximum work hours or have slept more than eight hours and still not be fit to work due to other causes—such as personal issues at home, drugs, alcohol, and other stressors that take a toll outside of the workplace.[9]

Lack of Objectivity
Fatigue measurements are often subjective, relying on judgment from the employee or their manager. For instance, some companies resort to a general face-to-face check-in or ask employees to sign a statement declaring they are good to go—as is the case with some airlines. However, these approaches make it difficult to quantify individual readiness and manage risk.[10]

Algorithmic Reliance
Some companies attempt to monitor fatigue by using commercial wearables that measure sleep, but these devices rely on algorithms based on general population data, not the unique makeup of each individual. For example, they may compare a driver's sleep to the rough guideline that people on average need 7–9 hours of sleep each night. By comparing sleep to general benchmarks, these wearables do not accurately reflect individual risk and do not account for medical conditions.

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[9] Ke Lu, et al. December 2022. Detecting driver fatigue using heart rate variability: A systematic review. Accident Analysis & Prevention, Volume 178106830.

[10] Neusa R. Adão Martins, Annaheim S, Spengler CM and Rossi RM. December 14, 2021. Fatigue Monitoring Through Wearables: A State-of-the-Art Review. Frontiers in Physiology. 12:790292. https://doi.org/10.3389/fphys.2021.790292.

Overall, traditional methods are not precise or personal enough to determine with certainty whether someone is truly ready to work safely. These approaches also put a lot of undue stress on operations managers and safety officers who want to make sure everyone is ready to work but also need to ensure the day's work gets done.

Enhancing Workforce Safety with the Psychomotor Vigilance Test

The key to accurately gauging employee readiness for work is to provide operational managers and safety managers with a direct measurement of an individual's readiness—something that takes the guesswork out of the decision.

Many enterprises have found the answer by using a Psychomotor Vigilance Test (PVT). Originally proposed as a 10-minute, reaction time test to measure one's ability to sustain attention, the PVT has been shortened to three minutes and was adopted by leading organizations, such as NASA, that further refined the testing protocol.

Today, PVT is the gold standard for measuring fatigue and objectively determining a person's ability to focus. Poor PVT performance can indicate an elevated risk of accidents,[11] and the PVT utility for alertness prediction is unquestioned.[12]

This new option for monitoring enterprise safety has six distinct advantages over traditional methods:

1. Directly measures a person's ability to maintain attention and, therefore, their fitness to work.
2. Identifies individuals that present an increased risk to the company because they are impaired by fatigue, drugs, alcohol, and other factors.
3. Avoids violating worker privacy by identifying impaired workers without pinpointing the source of impairment. A manager simply knows the user failed the test, but does not know whether the cause is lack of sleep, being overworked, drugs, alcohol, or personal stress.
4. Provides a personalized measurement for each user rather than comparing them to population averages. The PVT provides a specific and direct evaluation for an individual compared to a personal baseline, giving insights into that individual's singular ability to perform.
5. Measures a person's readiness in real time. Operations managers and safety officers can use the PVT results to determine if a person is ready at that precise moment. They can intercede if an employee fails the PVT and reassign the person to another position or offer resources to help them overcome the condition causing the failed tests.
6. Can be completed virtually at any time or location using a wearable PVT measuring device, making it possible to confirm the employee's readiness to perform at crucial points during the work period.

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[11] Maki, K. A., Fink, A. M., & Weaver, T. E. 2022. Sleep, time, and space-fatigue and performance deficits in pilots, commercial truck drivers, and astronauts. Sleep advances: a journal of the Sleep Research Society. 3(1), zpac033. https://doi.org/10.1093/sleepadvances/zpac033

[12] Lim, J., & Dinges, D. F. 2008. Sleep deprivation and vigilant attention. In D. W. Pfaff & B. L. Kieffer (Eds.), Molecular and biophysical mechanisms of arousal, alertness, and attention (pp. 305–322). Blackwell Publishing.

Information Learned from Psychomotor Vigilance Testing

Organizations using a PVT test to monitor for safety risks typically establish an individualized PVT baseline measurement for each worker and then require each worker to take a PVT test at the beginning of their shift. Managers can compare the results to the person's baseline to determine trends across four attributes:

- Speed—how fast users react to a stimulus.
- Standard deviation—the variability in the speed at which users react to the stimulus.
- Errors of omission—how often users suffer a lapse, failing to respond to the stimulus.
- Errors of commission—how often users react when there is no stimulus (false starts).

Errors of omission and commission are particularly critical as they indicate how prone the user is to an accident while operating a vehicle, machine, or heavy equipment. Managers can evaluate each worker's PVT test results prior to a shift and elect to switch personnel if a worker's PVT measurement has meaningfully worsened relative to their baseline. In addition, workers on long shifts, such as truck drivers, can retake the test during their shift to verify that they are still operating at safe levels..

Each company can tolerate a unique level of risk and, therefore, can set their own level at which they want managers to take action to reduce the risk of accident

Assessing Helicopter Pilot Readiness: A Psychomotor Vigilance Test Case Study[13]

As part of a fatigue risk management program, an air medical evacuation firm conducted a study to evaluate the validity of a three-minute psychomotor vigilance test. The study measured the workforce fitness of helicopter pilots and other safety-critical personnel.

Crew members self-administered an alertness assessment, incorporating a three-minute PVT at different time points during their duty schedule. The prevalence of alertness deficits was evaluated based on a failure threshold of 12 errors—considering both lapses and false starts.

To evaluate the validity of the PVT, the frequency of failed assessments was evaluated relative to crew member position and the timing of the assessment. The researchers also considered the duty schedule, the time of day, and sleep quantity in the last 24 hours.

The results of this test revealed that 2.1% of assessments generated failing PVT scores. The researchers also found that obtaining less than 7–9 hours of sleep was associated with systematic increases in the failure rate. Obtaining less than four hours of sleep was associated with a frequency of failed assessments that was nearly 3X higher.

These results provide evidence of the validity of PVT as well as the suitability of the failure threshold to support fatigue risk management in safety-critical operations.

Pison has detected similar results in an independent test of Army personnel. In that test, PVT tests conducted with Pison wearables were able to identify specific pilots that were most affected by the increased workload of their mission as shown by higher error rates in their individual PVT tests.

Pison-Powered Wearables for Monitoring Safety Risks

Pison has developed a neural sensor that powers numerous wrist-worn, wearable devices for taking PVT measurements. The devices complement existing enterprise safety applications by providing a convenient, new measurement that accurately reflects an individual's cognitive state and their ability to perform.

Pison-powered wearables take PVT measurements by providing a visual stimulus (i.e., a light) to tell the user when to react. The devices also contain Pison's unique neural sensor, which uses the science of electroneurography to detect when the user moves their hand in response to the visual stimulus.

This all-in-one system for administering PVT tests allows for more accurate and fast measurements. Users can take the test from anywhere—in a vehicle, on a manufacturing line, or in a warehouse. Managers can then compare the results to baseline scores to identify degradations from fatigue, drugs, alcohol, and other impairments that are specific to each person.

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[13] Daniel J. Mollicone, et al. Jan 17, 2023. Use of the psychomotor vigilance test to aid in the selection of risk controls in an air medical transport operation. Sleep Advances.

Another advantage is accuracy. The self-contained Pison devices generate stimuli and measure neural reactions directly off a common system clock. This eliminates the delays of computer-based testing systems and allows Pison to measure reaction time without the variability introduced by computer-based reaction time tests. This results in repeatable and reliable test times with one millisecond (0.001 seconds) precision.

The PVT readings collected by the wearable devices are displayed to operations managers, safety officers, and other risk management decision makers in the organization via an online dashboard. Visual displays allow managers to identify and act on areas of risk. With the ability to configure alerts, the dashboard makes it easy to spot anyone who is degrading and presenting an elevated risk to operations based on their PVT baseline scores.

Instant Insights from Pison-powered Dashboards

- Set quantified real-time readiness metrics.
- View and mitigate safety risks.
- Identify who is ready to work.
- Receive alerts on user trends.
- Determine if readiness tactics work well.

A Direct Method of Quantifying Readiness for Work

Current workforce safety solutions do not accurately identify a person whose ability to work is hampered by lack of sleep, drugs, alcohol, stress and other factors. Pison-powered wearables offer the better alternative to determine readiness for work by providing a direct, real-time, and personalized measurement of an employee's ability to safely work.

The devices use an on-body stimulus and neural sensor to ensure accurate and personalized results while also enabling testing in the field at any moment. With these capabilities, operations managers and safety officers can better manage human risk to ensure workforce safety while also helping their companies achieve productivity goals.

To learn more about our workforce solutions, contact Pison today.

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