PULSAR INFORMATICS

Fatigue Model

Fatigue estimates provided by the Fatigue Meter are based on a validated biomathematical fatigue model (McCauley, Kalachev et al. 2013). The fatigue model has been validated based on laboratory data collected at the University of Pennsylvania and Washington State University.

This model accounts for the two primary biological processes that govern human sleep/wake cycles and alertness levels: the homeostatic process and the circadian process. The homeostatic process represents the buildup of sleep pressure over time awake. The circadian process (“circadian” means “about a day”) makes an individual alert during their biological day and sleepy during their biological night.

An additional model component accounts for circadian misalignment—a mismatch between individuals’ internal circadian rhythm and the time that they are asleep or awake. Circadian misalignment occurs when working at night but also occurs when crossing time zones (this is what causes jet lag). When crossing time zones, the individual’s internal “body clock” time becomes misaligned with the local clock time. An individual who travels to a new time zone and hasn’t had adequate time to adjust will typically experience fatigue during daylight hours and be unable to sleep well during local nighttime.

The effects of jet-lag are temporary; eventually the individual’s internal body clock will synchronize with the local environment. This synchronization is a gradual process that occurs over days and is dependent on the number of time zones crossed. While the neurobiology that governs resynchronization is complex, one commonly used model is that the “body clock” adjusts towards the local time zone at a rate of 1/2 of the difference every 24 hours (Darwent, Dawson et al. 2010). This is the model that Fatigue Meter uses to account for performance deficits due to jet lag. So, for example, if an individual travels from his or her domicile (say at Z+0) to a location with time zone Z+10, their “body clock” is assumed to adjust to Z+5 after 24 hours, Z+7.5 after 48 hours, Z+8.8 after 72 hours, etc.

Fatigue Meter will automatically estimate the individual’s sleep periods (calculated in terms of time spent in bed) given their duty schedule. Estimates of sleep timing and duration are based on mathematical model inputs related to sleep history, internal circadian phase (body clock time) and time of day. At “baseline” with no imposed work schedule constraints or flights, the individual is assumed to spend 8 hours time in bed, starting at 23:30 in their domicile time zone. This off-duty behavior model has been validated based on operational data collected across various industries, including the business aviation industry.

Originally developed for NASA and DOD, our technologies offer the best in security, performance, and ease of use.

Fatigue Meter shows you exactly how operational factors such as long duty hours, night shift work, and restricted sleep opportunities combine and contribute to elevated fatigue risk in your operation.

In-depth understanding enables smarter mitigation strategies such as a worker reassignment, nap and break strategies, and schedule changes.

Ready to start managing driver fatigue risk?

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