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SENATE SUBCOMMITTEE ON

AVIATION OPERATIONS, SAFETY AND SECURITY

TESTIMONY OF

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Chairman Cantwell, Ranking Member Thune, and distinguished members of the Subcommittee: thank you for the opportunity to testify on sleep, fatigue, and performance in air traffic controllers. I am Gregory Belenky. I am physician-by-training and Research Professor and Director of the Sleep and Performance Research Center at Washington State University (WSU), Spokane. I joined WSU in 2004. Prior to that, I served for 29 years on active duty in the U.S. Army, developing systems to manage sleep and sustain performance in military operations. At WSU, we are continuing this work, studying sleep and performance in operational environments, environments in which if the human fails the system fails. Operational environments include military operations, medicine, all modes of air, land, and waterborne transportation, security work, first responders, energy generation, resource extraction (mining and drilling), financial markets, and industrial production. We study normal people under extremes of scheduling. We are supported by grants and contracts from the US Department of Transportation, the Department of Defense, and the National Institutes of Health, as well as state agencies, industry, and philanthropic foundations.

Chairman Cantwell, it is important for this Subcommittee, with its critical role in aviation safety to examine the recent incidents in which air traffic controllers have inadvertently fallen asleep or deliberately napped while on-shift. Questions abound. Is this a moral failing on the part of a few air traffic controllers or does it indicate a systemic problem in the organizing, staffing, and scheduling of air traffic control operations? I believe it is a systemic problem, specifically the well-described sleepiness and degraded performance that is generally characteristic of all night shift work – the difficulties encountered when trying to work when one should be asleep and trying to sleep when one should be awake (Drake and Wright, 2011). Air traffic controllers are the same physiologically as any other night shift worker, and the same principles apply. Given the structural realities of scheduling, the solution to this problem may lie in sanctioned, scheduled on-shift napping when working the night shift.

We know that fatigue, operationally defined as degraded performance, results from the interaction of sleep loss, circadian phase, and workload (McDonald, Patel, and Belenky, 2011; Wesensten et al., 2004).

Performance depends upon total sleep time in 24 hours. Thus sleep can be split into two or three sleep periods (a main sleep plus one or two naps) and will sustain roughly the same level of performance as a single consolidated sleep (Mollicone, et al., 2007, 2008). Simply put, naps add to recuperative sleep time. If the main sleep period is truncated as it is in shift work, naps can make up the difference.

The circadian rhythms in task performance and sleep propensity parallel the 24-hour circadian rhythm in core body temperature. Task performance peaks in mid-evening just subsequent to the peak in the circadian core body temperature and troughs in the early morning just subsequent to the trough in circadian core body temperature. Twelve hours out of phase with performance, sleep propensity troughs in mid-evening and peaks in the early morning. It is difficult to fall asleep and to stay asleep when core body temperature is rising or high and easy to fall asleep and to stay asleep when core body temperature is falling or low. Hence, the reduced daytime sleep time in people working the night shift and attempting sleep during the day. Sleep is particularly difficult in the early to mid-evening, the so-called "forbidden zone" for sleep.

What can we learn from these incidents of air traffic controllers sleeping on duty? By inadvertently falling asleep or deliberately napping on-shift, air traffic controllers are pointing to the problem. They are identifying shifts and schedules of shifts that carry relatively higher fatigue risk and are in need of fatigue mitigation. And, by sleeping on shift they are pointing to the solution. The primary mitigation for fatigue is sleep. Additional sleep could come in the form of sanctioned, scheduled on-shift napping.

It is a step forward to have two air traffic controllers on duty at all times even during slow shifts. However, the full value of this increased staffing will likely only be realized if it is leveraged by napping on-shift. As commercial airline pilots will tell you, simply augmenting flight crews without providing an opportunity for sleep isn't much help – it just means three or four tired pilots instead of two.

In the early morning of August 27, 2006, Comair Flight 5191 crashed on takeoff from Lexington, Kentucky killing 49 of the 50 people on board. The crash occurred at a time when the sole air traffic controller on duty was working the last shift of a 2-2-1 series of shifts consisting of two evening shifts, two day shifts, and finally one night shift. Working through the night, he was coming to the end of the final night shift of the 2-2-1schedule when the crash occurred. The day shift preceding this trailing night shift began early the previous morning and ended mid-afternoon. The air traffic controller then had the regulation-mandated 8-9 hours off duty before going back on duty in the late evening for the night shift. He managed only 2-3 hours of "not real good" sleep in the late afternoon. He then remained awake through the evening. His sleep was truncated because the bulk of his sleep opportunity fell in the early to mid-evening, the so-called "forbidden zone" for sleep. With respect to the relationship between sleep and circadian physiology, the controller took the maximum possible advantage of the sleep opportunity he was given. He went back on duty at 11:30 PM with his shift projected to end at 7:30 AM. Comair 5191 crashed at 6:06 AM as the captain, first officer, and the air traffic controller failed to detect that the plane was on the wrong runway, a runway much too short for successful takeoff. A fatigue analysis, including mathematical performance prediction modeling, suggests that at the time of the crash the air traffic controller's performance was impaired by a combination of sleep restriction and working at his circadian low (see Figure 1) (Pruchnicki, Wu, and Belenky, 2011). Having another controller on duty to enable alternating on-shift naps would have been the only way to increase sleep time in the controller on the 2-2-1 schedule during the 24 hours preceding the crash. Though the National Transportation Safety Board did not implicate fatigue as a cause, I believe that had the air traffic controller had more sleep and been less fatigued he might have detected the error in runway choice prior to the attempted takeoff and in time to avert the disaster.

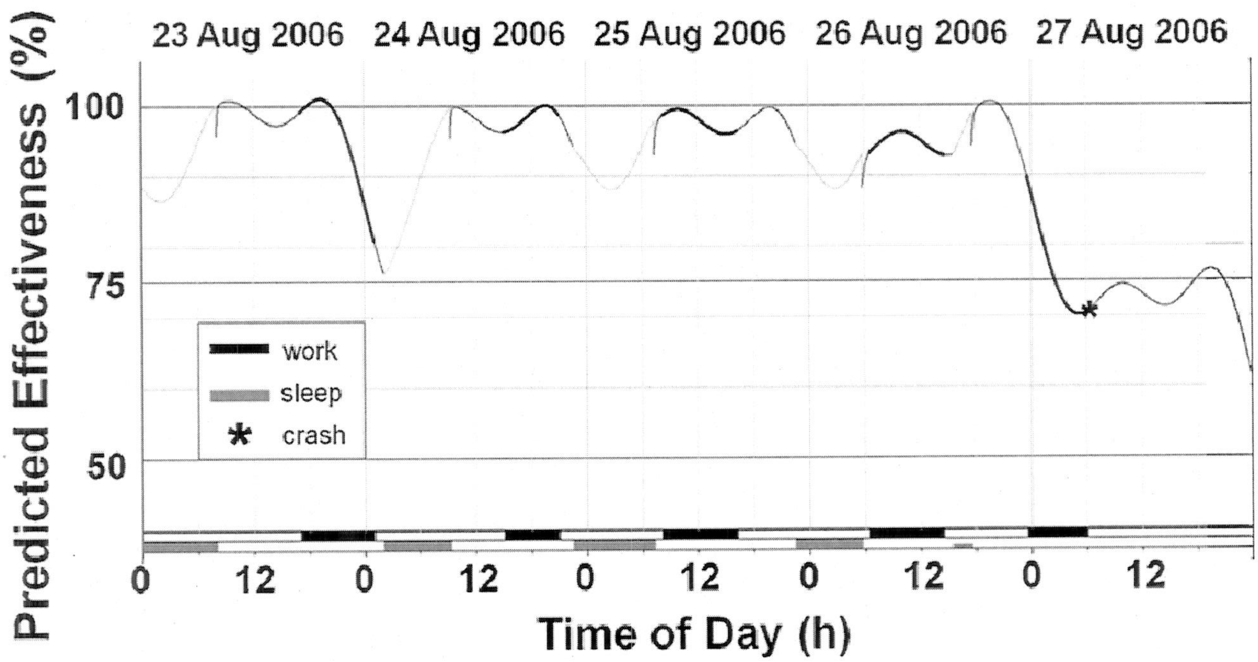

Figure 1: Performance prediction for the air traffic controller on duty during the Comair 5191 crash. Note that his predicted effectiveness at the time of the crash, marked by the asterisk, was 71% (from Pruchnicki, Wu, and Belenky, 2011).

Twenty years ago, then NASA scientists Curt Graeber and Mark Rosekind conducted a pioneering study that demonstrated the effectiveness of scheduled cockpit napping in sustaining performance and vigilance in flights across the Pacific (Rosekind, et al. 1994). In this study, on-shift napping improved performance.

Recently, Charles Czeisler and colleagues in the Harvard Work Hours Health and Safety Group carried out a remarkable study of rates of medical errors associated with extended work hours and sleep loss (Landrigan, et al., 2004; Lockley, et al., 2004). They found that when publically-funded physicians in post-graduate residency training were decreased from an 85-hour to a 65-hour work week, and, as a result, obtained more sleep, they experienced a one third reduction in the rate of serious medical errors that included a five-fold decrease in the rate of serious diagnostic errors. In this study, limits on work hours increased sleep and improved performance.

American, Continental, and Delta Airlines are currently conducting studies in pilots flying augmented (4-pilot) long-range flights. From these and other studies, it is apparent that pilots are able to take advantage of the on-board crew bunk facilities during cruise for rest and sleep. And, they do sleep. This sleep is on-shift napping, sanctioned by the FAA and paid for by the airlines.

I expect that an effective way to sustain operational performance and well-being in air traffic controllers working the night shift is sanctioned, scheduled on-shift napping. We could validate this proposed countermeasure by testing the effect of sanctioned, scheduled napping on performance and vigilance in night shift operations in select air traffic control sites. Previous work in air traffic controllers working the night shift has shown that even short, poor quality naps improve alertness and performance (Signal et al., 2009).

As a research scientist, I can describe what the scientific evidence suggests is possible and propose ways to develop more relevant evidence. The members of this subcommittee, as well as labor and air traffic control management, must decide what is feasible and desirable within the range possible countermeasures as supported by the evidence

Thank you, Chairman Cantwell for the opportunity to testify before the Sub-committee. I would be happy to answer any questions that you and the Members of the Committee may have.

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