



Naturalistic field study of the restart break in US commercial motor vehicle drivers: Truck driving, sleep, and fatigue



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ABSTRACT

Commercial motor vehicle (CMV) drivers in the US may start a new duty cycle after taking a 34-h restart break. A restart break provides an opportunity for sleep recuperation to help prevent the build-up of fatigue across duty cycles. However, the effectiveness of a restart break may depend on its timing, and on how many nighttime opportunities for sleep it contains. For daytime drivers, a 34-h restart break automatically includes two nighttime periods. For nighttime drivers, who are arguably at increased risk of fatigue, a 34-h restart break contains only one nighttime period. To what extent this is relevant for fatigue depends in part on whether nighttime drivers revert back to a nighttime-oriented sleep schedule during the restart break. We conducted a naturalistic field study with 106 CMV drivers working their normal schedules and performing their normal duties. These drivers were studied during two duty cycles and during the intervening restart break. They provided a total of 1260 days of data and drove a total of 414,937 miles during the study. Their duty logs were used to identify the periods when they were on duty and when they were driving and to determine their duty cycles and restart breaks. Sleep/wake patterns were measured continuously by means of wrist actigraphy. Fatigue was assessed three times per day by means of a brief psychomotor vigilance test (PVT-B) and a subjective sleepiness scale. Data from a truck-based lane tracking and data acquisition system were used to compute lane deviation (variability in lateral lane position). Statistical analyses focused on 24-h patterns of duty, driving, sleep, PVT-B performance, subjective sleepiness, and lane deviation. Duty cycles preceded by a restart break containing *only one* nighttime period (defined as 01:00–05:00) were compared with duty cycles preceded by a restart break containing *more than one* nighttime period. During duty cycles preceded by a restart break with *only one* nighttime period, drivers showed more nighttime-oriented duty and driving patterns and more daytime-oriented sleep patterns than during duty cycles preceded by a restart break with *more than one* nighttime period. During duty cycles preceded by a restart break with *only one* nighttime period, drivers also experienced more lapses of attention on the PVT-B and increased lane deviation at night, and they reported greater subjective sleepiness. Importantly, drivers exhibited a predominantly nighttime-oriented sleep schedule during the restart break, regardless of whether the restart break contained only one or more than one nighttime period. Consistent with findings in laboratory-based studies of the restart break, the results of this naturalistic field study indicate that having at least two nighttime periods in the restart break provides greater opportunity for sleep recuperation and helps to mitigate fatigue.

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1. Introduction

Hours-of-service (HOS) regulations for the trucking industry in the United States require commercial motor vehicle (CMV) drivers to take a 34-h restart break at the end of a duty cycle before they can begin another duty cycle. This “restart rule” takes effect when drivers accumulate 60 h on duty in a rolling 7-day period or 70 h on duty in a rolling 8-day period. The restart break provides an

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opportunity for sleep recuperation between duty cycles and may help to mitigate the build-up of fatigue.

The 34-h restart rule does not take into account the start and end times of the prior duty schedule and, therefore, ignores the influence of circadian rhythmicity on sleep and on waking alertness (Monk, 1990; Satterfield and Van Dongen, 2013). Fig. 1 illustrates why this is relevant in the context of the HOS regulations. That is, a daytime driver (or any driver whose duty cycle ends in the evening hours) automatically has two nighttime periods for sleep recuperation in the restart break. However, a nighttime driver (or any driver whose duty cycle ends after 01:00 and before 19:00) only has one complete nighttime period for sleep recuperation in the restart break, unless the duration of the restart break is extended beyond the minimum 34 h. Here a nighttime period is defined by the Federal Motor Carrier Safety Administration (FMCSA) as the period from 01:00 until 05:00 (Department of Transportation, 2011). This definition is based on the time zone of the driver's home terminal (e.g., for a driver whose home terminal is in the Eastern Time Zone, the nighttime period is defined as the period from 01:00 until 05:00 Eastern Time even if the driver is en route in another time zone).

In laboratory research, a 34-h restart break was found to be sufficient to maintain optimal alertness from one simulated duty cycle to the next when duty periods were scheduled during the day, but insufficient to prevent the build-up of fatigue across duty cycles when duty periods were scheduled during the night (Van Dongen and Belenky, 2010; Van Dongen et al., 2011). It was also shown that when duty periods were scheduled during the night, extending the restart break to include a second nighttime period helped to mitigate the build-up of fatigue across duty cycles (Van Dongen et al., 2010). Based in part on these findings, the FMCSA implemented new HOS regulations for CMV drivers, effective February 27, 2012, with a compliance date of July 1, 2013 (Department of Transportation, 2011). The new regulations included a provision requiring CMV drivers to include at least two nighttime periods (01:00–05:00) in their restart break, potentially extending the duration of the restart break beyond 34 h.¹

When the new regulations were promulgated, stakeholders raised concern about the practical effectiveness of the new restart provision. For example, the requirement to include two nighttime periods in the restart break was based on the implicit assumption that the nighttime periods would help to mitigate fatigue because drivers use these periods for sleep recuperation. However, it has been suggested that nighttime drivers may choose to maintain a daytime sleep schedule during their restart break, which would render the new requirement ineffective. The FMCSA suspended enforcement of the new restart provision and the regulations reverted back to the original restart provision, effective December 16, 2014, pending further research.

Here we present the findings of the first naturalistic study in the field to systematically investigate the restart break in CMV drivers. Our study design resembles that of earlier naturalistic field studies in CMV drivers focused on other aspects of the HOS regulations in the US. Specifically, Hanowski et al. (2007) investigated the efficacy of a new rule in a 2003 revision of the HOS regulations, which required CMV drivers to extend their time off between duty periods from 8 h to 10 h. The investigators collected sleep data by means of wrist actigraphy in 73 CMV drivers for 7 consecutive days. Drivers obtained more sleep when time off was extended to 10 h, which was interpreted as supportive of the new HOS rule for time off duty. Similarly, Hanowski et al. (2009) investigated the safety implications of a separate rule in the 2003 revision of the HOS regulations,

¹ The new HOS regulations also limited the use of a restart break to no more than once every 168 h. That aspect is irrelevant in the current field study and beyond the scope of this paper.

which allotted drivers an extension of driving time from 10 h to 11 h in a 14-h duty period. They collected driving data by means of a truck-based data acquisition system for approximately 12 weeks and assessed critical incident risk in 103 CMV drivers. It was found that extending driving time from 10 h to 11 h did not significantly increase the critical incident risk, which was interpreted as supportive of the new HOS rule for maximum driving time per duty period.

Our naturalistic field study of the restart break in CMV drivers used similar methodology, and the primary objective of the study was to investigate the efficacy of the new HOS restart provision requiring CMV drivers to include at least two nighttime periods in their restart break. The study was conducted prior to the compliance date for the new restart provision of July 1, 2013, while the original restart provision was still in effect. The original restart provision required a 34-h restart break at the end of a duty cycle regardless of how many nighttime periods were included in the restart break. We measured sleep, psychomotor vigilance performance, self-reported sleepiness, and driving performance across two duty cycles and the intervening restart break. Data were collected from 106 drivers, covering a grand total of 30,241 field study hours (25,185 h during duty cycles and 5056 h during restart breaks), comprising 1260 duty days, capturing 414,937 mi (8049 h) of driving, and including 3169 assessments of psychomotor vigilance performance and self-reported sleepiness.

2. Methods

2.1. Participants

US truck drivers utilizing the restart provision of the HOS regulations for CMV drivers were recruited for the study. Participating drivers were fit for duty by regulatory standards and had a valid commercial driver's license. A total of $N = 106$ drivers completed the study. They were 100 men and 6 women, ranging in age from 24 to 69 years (mean \pm SD: 45.4 \pm 10.7 years). They reported to have up to 39 years of experience as a CMV driver (mean \pm SD: 12.4 \pm 8.7 years). Three drivers were owner-operators independently contracting with a carrier. The others were employed with one of three carriers. These drivers were with their current carrier for up to 25 years (mean \pm SD: 6.3 \pm 6.4 years). The sample consisted of 44 local drivers, 26 regional drivers, and 36 over-the-road (long-distance) drivers.

The study was approved by the Institutional Review Board of Washington State University. All drivers gave written, informed consent. Drivers were compensated for their study participation. They were informed that their study participation would not affect their employment or their relationship with their carrier and their data would be kept strictly confidential. Data were protected from disclosure by means of a Certificate of Confidentiality issued for this study by the National Institutes of Health.

2.2. Procedures

Drivers' duty and driving schedules were governed by the HOS regulations for CMV drivers in the US, which include the following provisions:

- *Duty period:* Drivers may drive 11 h within a 14-h window after coming on duty² following 10 consecutive hours off duty;

² In the HOS regulations for CMV drivers, on-duty time is defined as all time from the moment a driver begins to work or is required to be in readiness to work until the moment the driver is relieved from work and all responsibility for performing work.

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