Accident Analysis and Prevention xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

# How shift scheduling practices contribute to fatigue amongst freight rail operating employees: Findings from Canadian accident investigations

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ARTICLE INFO

*Keywords:*
Human factors
Operator behavior
Train crew

ABSTRACT

Canada's freight rail system moves 70% of the country's surface goods and almost half of all exports (RAC, 2016). These include dangerous goods. Anonymous survey of freight rail operating employees conducted by the Teamsters Canada Rail Conference (TCRC, 2014) revealed that many do not report getting enough sleep because of their work schedules, and that fatigue may be affecting their performance at work. Besides general impairments in attention and cognitive functioning, fatigue in railway operating employees slows reaction time to safety alarms and impairs conformance to train operating requirements. Shift scheduling practices can contribute to sleep-related fatigue by restricting sleep opportunities, requiring extended periods of wakefulness and by disrupting daily (circadian) rhythms. The primary goal of accident investigation is to identify causal and contributing factors so that similar occurrences can be prevented. A database search of Transportation Safety Board (TSB) rail investigation reports published in the 21-year period from 1995 to 2015 identified 18 that cited sleep-related fatigue of freight rail operating employees as a causal, contributing, or risk finding. This number represents about 20% of TSB rail investigations from the same period in which a human factors aspect of freight train activities was a primary cause. Exploration of accident themes suggests that management of fatigue and shift scheduling in the freight rail industry is a complex issue that is often not conducive to employee circadian rhythms and sleep requirements. It also suggests that current shift scheduling and fatigue management practices may be insufficient to mitigate the associated safety risk. Railway fatigue management systems that are based on the principles of modern sleep science are needed to improve scheduling practices and mitigate the ongoing safety risk.

## 1. Introduction

Fatigue is pervasive in today's society, especially in the transportation industry. Most people need between seven and eight hours of continuous sleep every night to feel well rested; however many Canadians report getting fewer than six hours' sleep per night, and being dissatisfied with the quality of the sleep they do obtain (Morin et al., 2011). One online survey found that nearly 58% of Canadian respondents said they felt tired "most of the time." (CBC News, 2011). A 2012 poll conducted by the U.S. National Sleep Foundation, a leading sleep health organization, found that many transportation workers reported not getting enough sleep because of their work schedules (NSF, 2012); that is, they might work too many hours at a stretch, or their work hours, which are irregular, coincide with normal sleep times. The NSF poll found that, compared to non-transportation workers, train operators and airline pilots were the most likely to report sleep-related job performance problems. Research of U.S. railway operations (Gertler et al., 2013) using logbook entries has found that railroad workers, as a group, are more likely than other working Americans to get less than 7 h of total sleep on workdays. Workers in freight rail operations were found to have the highest exposure to the risk of fatigue due to unpredictable schedules, longer shifts, and more nighttime work compared to other railway worker groups.

Disruptions to sleep or sleeping patterns in personnel occupying safety critical positions may cause performance detriments that increase the risk of incidents and accidents. Disruptions include acute sleep disruptions, chronic sleep disruptions, continuous wakefulness, circadian rhythm disruptions, sleep disorders or other medical and psychological conditions, illnesses or drugs that affect sleep or sleepiness.

Besides general impairments in attention and cognitive functioning, fatigue in railway operating employees slows reaction time to safety alarms (Hildebrandt et al., 1974) and impairs conformance to train operating requirements, including increasing fuel use, heavy brake applications and maximum speed violations (Dorrian et al., 2007). International research on fatigue in the rail industry confirms the

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https://doi.org/10.1016/j.aap.2018.01.027
Received 2 September 2017; Received in revised form 8 January 2018; Accepted 19 January 2018

relationship between fatigue and impaired train operating performance. For example, research conducted on behalf of the U.S. Federal Railroad Administration (FRA) (Gertler et al., 2013) found that the risk of being involved in a human factors-related railway accident was elevated 11% to 65% above chance by a worker's exposure to fatigue. Parenthetically, the amount of sleep and time of day when sleep occurred (both determined by shift schedule) were found to account for between 85% and 96% of workers' fatigue exposure. Similar results have been found in research conducted by the U.K. Rail Safety and Standards Board (RSSB) (Bowler & Gibson, 2015). Analysis of data from 246 high risk railway incidents in the U.K. confirmed the contribution of fatigue to impaired operational performance. Fatigue was identified as either a contributing or performance shaping (aka "risk") factor in 21% of incidents reviewed. Of these incidents, 80% involved locomotive operators, who were also overrepresented (compared to signalers or maintainers) in terms of experiencing "work-related", as opposed to "home-life related", fatigue.

Shift scheduling practices can contribute to sleep-related fatigue by:

1 restricting opportunities to obtain sufficient restorative sleep (acutely or chronically);
2 requiring extended periods of wakefulness; and/or
3 disrupting daily (circadian) rhythms.

Canada's freight rail system is vital, moving about 70% of the country's surface goods, including dangerous goods, and almost half of all exports (RAC, 2016). It is important, therefore, to limit accident and incident risk in the freight rail system. One of the goals of accident investigation is to determine the causal and contributing factors that led to an accident so as to minimize the likelihood that a similar accident will happen in future. To assist its investigators, the TSB has published and updated a guide to investigating for fatigue since 1997. However, while there are typically between 1200 and 1400 rail occurrences reported to the TSB each year under mandatory reporting requirements, practical considerations dictate that only a portion (about 1%) are fully investigated by the TSB and result in a published TSB report. Therefore, it is challenging to estimate statistically the prevalence of fatigue-related accidents in the railway operating context. Nevertheless, review of those investigations where fatigue was concluded to have played a role can increase our understanding of the issue, especially when considered in light of recent advances in sleep science.

To this end, the goal of the present research was to review rail investigation reports published in the 21-year period from 1995 to 2015 (the most recent year for which data were available), search for key words, and produce a list of those where fatigue in freight rail operational employees was causal, contributory or determined to present a risk. Report findings and recommendations relating to fatigue of freight railway operating employees were explored, and grouped according to theme to better understand the primary issues affecting fatigue in freight rail operating employees.

## 2. Method

### 2.1. Database review

The TSB's Railway Occurrences Database System (RODS) stores information on federally regulated railway occurrences in Canada. Data fields in RODS include, for example, accident location, railway, track and train type, train and road speed, crossing characteristics, train and road vehicle occupant injuries and fatalities, and a summary of each occurrence. A full-text search was conducted on approximately 630 rail occurrence reports dating from 1995 to 2015. Key word combinations were searched for proximity. Word combinations and variants included:

- Sleep(y|ing) + fatigue(d)
- Rest(ed|ing) + fatigue(d)
- Work/rest + fatigue(d)
- Alert(ness) + fatigue(d)
- Alert(ness) + sleep(y|ing)

Key word combinations were also used to exclude some records; for example, those that included:

- Fatigue + crack(ing)
- Fatigue + fail(ure)

Occurrences were not restricted to those from a given geographical area. Those occurrence summaries identified by the search and any associated investigation reports were reviewed and scrutinized for themes. The fatigue-related themes sharing commonality were noted and grouped.

To get a sense of the proportion of investigations where a human factors aspect of freight train activities was a primary cause that also involved fatigue of the operating crew, all rail occurrences from the year 1995 to 2015 were reviewed and coded. Since 1995, there had been 90 rail investigations in which a human factors aspect of freight train activities was noted as a primary cause.

## 3. Results and discussion

The RODS database contained 630 searchable rail occurrence reports for the period 1995 to 2015. From this initial data set, 217 reports were identified for further review based on the presence in the report text of key words relating to fatigue. Reports were triaged based on whether they referenced fatigue in materials, or mental or physical fatigue in humans. Of 217 reports, 84 were excluded because they dealt with metal fatigue, and 133 were retained. These 133 reports were studied, and 23 reports were identified where fatigue was deemed to have been a factor in the events of the occurrence (representing a causal, contributing, or risk factor). One report was removed from the data set because it dealt with passenger train operations (not freight). Another four reports were removed because the parties involved in the occurrences were other than train operating crew (i.e., rail traffic control, inspector, or maintenance crews).

From the initial data set, 18 occurrence reports[1] remained where operator fatigue was identified as a factor to the occurrence. This number represents about 20% of the 90 TSB rail investigations in which a human factors aspect of freight train activities was noted as a primary cause. The 18 investigation reports were reviewed, and seven common themes were identified. These seven themes are summarized next.

### 3.1. Themes from TSB investigation reports

Seven themes were extracted from the 18 TSB rail reports that identified sleep-related fatigue of freight railway operating personnel as a causal, contributing, or risk factor. Themes include:

1 Disruption of the normal sleep cycle,
2 The varied and unpredictable nature of railway shift scheduling,
3 Insufficient rest periods between shifts,
4 Extended periods of continued wakefulness due to shift length,
5 Cumulative effects of working extended hours over the long term,
6 Pressures on crews not to refuse shifts because of fatigue, and
7 Ineffective fatigue countermeasures.

Broadly, the seven themes fall into one of two general categories of challenges facing railways in efforts to effectively mitigate fatigue in

[1] TSB investigation reports R95S0021, R95V0218, R96Q0050, R96W0171, R97C0147, R98V0183, R99E0023, R03W0169, R05C0082, R06W0079, R07E0129, R07V0213, R09W0259, R10E0096, R10T0213, R11D0075, R11E0063, R14V0215.