

Hours of Service Regulations in the U.S. Railroad Industry: Time for a Change

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I. BACKGROUND

A. THE NATURE OF RAILROAD TRANSPORTATION WORK

Fatigue management in the transportation industry is a challenge because the industry operates on twenty-four hours a day, seven days a week (24/7). Operations in the maritime, rail, aviation, and the trucking industry are all 24/7. For the freight industry in particular, nighttime operations are preferred by freight companies and expected by customers because there is less competition for the roads and rails by passenger ve-

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hicles.¹ In contrast, operations in the passenger transportation sector are generally more predictably oriented towards the daytime and, in local travel, often involve split shifts.²

The issue of fatigue in transportation workers has been on the National Transportation Safety Board's (NTSB) "most wanted" list of recommended safety improvements since 1990.³ In 1999, the NTSB recommended that the Federal Railroad Administration (FRA) "establish scientifically based regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements."⁴ The FRA, however, has proposed "no statutory changes to the existing hours of service requirements."⁵

Under current law, a railroad employee must have at least eight consecutive hours of off-duty time following the completion of a work period and during the twenty-four hours before the employee may go on duty.⁶ An employee who has been on duty for more than twelve consecutive hours may not return for duty until the employee has had at least ten consecutive hours of off-duty time.⁷ It is common practice in the rail industry to transport road crews by cab from a train or terminal to a motel.⁸ If the crew is at a remote location, it may take an hour or more for the crew to reach its rest location. Thus, a twelve-hour shift can become thirteen or even fourteen hours if the crew must wait for its relief to arrive before being transported to the terminal.⁹ Upon arrival at the terminal the employee must usually spend extra time to drive home. Because crews are called at least two hours before they are to report for duty, a crew member may actually have only five hours or less of uninterrupted time for sleep.¹⁰

There are powerful incentives in place for both labor and management to maintain the current regulatory framework. Limiting hours of

1. Donald Sussman & Michael Coplen, *Fatigue and Alertness in the United States Railroad Industry Part 1: The Nature of the Problem*, (2000), <http://www.volpe.dot.gov/opsad/fataprblm.html> (last visited Oct. 2, 2006).

2. *Id.*

3. NAT'L TRANSP. SAFETY BD., ORIGINAL "MOST WANTED" LIST OF TRANSPORTATION SAFETY IMPROVEMENTS (Sept. 1990), at http://www.ntsb.gov/REcs/mostwanted/original_list.htm (last visited Feb. 16, 2006) [hereinafter "NTSB"].

4. NTSB, EVALUATION OF U.S. DEPARTMENT OF TRANSPORTATION EFFORTS IN THE 1990s TO ADDRESS OPERATOR FATIGUE, NTSB/SR-99/01, 26 (1999), available at <http://www.ntsb.gov/Publictn/1999/SR9901.pdf> (last visited Feb. 16, 2006).

5. S. REP. NO. 108-182, at 6 (2003).

6. *Id.*

7. *Id.*

8. *Id.*

9. *See id.*

10. *Id.*

service would force the railroads to hire additional workers. Consequently, employees would suffer a reduction in their earning power.¹¹ Railroad companies would not only need to hire additional workers, but also provide training, benefits, and possible salary guarantees. In addition, railroad employees in the operating crafts have a strong tradition of independence and often resist changing work practices, especially ones they feel that they have adjusted to by reason of experience, seniority, and training. In general, railroad management boards and rail labor have worked cooperatively on several initiatives to address fatigue - a consensus, however, has not been reached to identify an overall approach.¹²

B. REGULATORY ACTIVITY

In an effort to protect both the public and the employees of the railroad industry there have been several efforts to legislate employee working times to prevent the occurrence of accidents and injuries that ordinarily arise from human fatigue. Most of the regulations were first enacted in the 1900's and have had little revision since then. In 1907, Congress approved the Railroad Hours of Service Act, establishing the maximum number of hours certain classes of railroad employees may work.¹³ It was substantially revised in 1969, and amended again in 1976 and 1988.¹⁴ The NTSB has called for a revision of the hours of service based on more up-to-date and current scientific thinking.¹⁵

1. *Regulatory Activity in the Trucking Industry*

The trucking industry in the United States is monitored and regulated by the Federal Motor Carriers Safety Administration (FMCSA).¹⁶ Since 1995, the FMCSA (formerly a division of the Federal Highway Administration (FHWA)) has been working on revising the Hours of Service (HOS) requirements for the trucking industry.¹⁷

The NTSB has issued its yearly list of the top ten safety problems for the last ten years. While the Hours of Service regulations for the railroad industry are not currently on the list, the conditions set forth by the regulations have been mentioned repeatedly as a contributing factor in accidents investigated by NTSB.¹⁸ In fact, NTSB has noted that fatigue is a

11. *Id.*

12. *See id.*

13. S. REP. NO. 108-182, at 1 (2003).

14. NTSB, *supra* note 4, at 2.

15. *See id.* at 19.

16. *Pub. Citizen v. Fed. Motor Carrier Safety Admin.*, 374 F.3d 1209, 1211 (D.C. Cir. 2004).

17. *See id.* (Prior to the FMCSA, the FHWA was responsible for promulgating HOS rules regulating commercial motor vehicle drivers).

18. NTSB, *supra* note 4, at 8.

significant contributor to the occurrence of transportation related accidents and in 1999 called on the different modes to address these issues directly recommending that “the DOT require the modal administrations to modify the appropriate *Codes of Federal Regulations* to establish scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements.”¹⁹

Reform of the HOS regulations has been under consideration by the FMCSA for several years.²⁰ In 1995, Congress, concerned about the effect of fatigue as a contributing factor in commercial motor vehicle crashes, directed the FHWA to begin a rulemaking to increase driver alertness and reduce fatigue-related incidents.²¹ Because the FHWA never issued the required notice of rulemaking, the FMCSA took over the task of revising the existing commercial motor vehicle HOS rules.²² Specifically, it provided that the FHWA

. . . shall issue an advance notice of proposed rulemaking dealing with a variety of fatigue-related issues pertaining to commercial motor vehicle safety (including 8 hours of continuous sleep after 10 hours of driving, loading, and unloading operations, automated and tamper-proof recording devices, rest and recovery cycles, fatigue and stress in longer combination vehicles, fitness for duty, and other appropriate regulatory and enforcement countermeasures for reducing fatigue-related incidents and increasing driver alertness). . . .²³

In April 2003, FMCSA issued the first significant revision to the HOS regulations in over sixty years.²⁴ The new regulations provided an increased opportunity for drivers to obtain necessary rest and restorative sleep, and at the same time reflect operational realities of motor carrier transportation.²⁵ According to Laux, the rules specified a fourteen-consecutive-hour window, after which a property-carrying commercial motor vehicle driver would not be allowed to begin driving, although such a driver is allowed to continue to do other work which must be charged against the overall sixty hours in seven days or seventy hours in eight days on-duty time limit.²⁶ A property-carrying driver is allowed to drive for

19. *Id.* at 24.

20. *See Pub. Citizen*, 374 F.3d at 1211.

21. *See id.*

22. *Id.*

23. *Id.*

24. FED. MOTOR CARRIER SAFETY ADMIN., THE 2003 HOURS OF SERVICE REGULATIONS (2003) [hereinafter “FMCSA”], at <http://www.fmcsa.dot.gov/rules-regulations/truck/driver/hos/brochure.htm> (last visited Oct. 3, 2006).

25. *Id.*

26. Patricia M. Laux, *Hours of Service: Revisiting the Rule* (Jan. 1, 2006), available at <http://www.drivingforcemag.com/index.php?id=385> (last visited Oct. 2, 2006).

up to eleven hours after having ten hours off duty.²⁷

The new HOS rules were struck down in July 2004 by the appeals court because the FMCSA had failed to consider the effects of the hours-of-service rules on driver health, as required by Congress.²⁸ On August 19, 2005, the FMCSA announced new HOS regulations.²⁹ The revised rules were published despite the ruling by the court of appeals. The new rule contains most of the major provisions of the 2003 hours-of-service regulations with the exception of sleeper berth and short haul regulations.³⁰ The Final Rule, promulgated in April 2003 included the following provisions:

- (a) No motor carrier shall permit or require any driver used by it to drive a property-carrying commercial motor vehicle, nor shall any such driver drive a property-carrying commercial motor vehicle:
 - (1) More than 11 cumulative hours following 10 consecutive hours off duty; or
 - (2) For any period after the end of the 14th hour after coming on duty following 10 consecutive hours off duty, except when a property-carrying driver complies with the provisions of 395.1(o).
- (b) No motor carrier shall permit or require a driver of a property-carrying commercial motor vehicle to drive, nor shall any driver drive a property-carrying commercial motor vehicle, regardless of the number of motor carriers using the driver's services, for any period after-
 - (1) Having been on duty 60 hours in any 7 consecutive days if the employing motor carrier does not operate commercial motor vehicles every day of the week; or
 - (2) Having been on duty 70 hours in any period of 8 consecutive days if the employing motor carrier operates commercial motor vehicles every day of the week.
- (c)
 - (1) Any period of 7 consecutive days may end with the beginning of any off duty period of 34 or more consecutive hours; or
 - (2) Any period of 8 consecutive days may end with the beginning of any off duty period of 34 or more consecutive hours.³¹

The sleeper berth provision for the 2005 rule reads as follows: "CMV drivers using the sleeper berth provision must take at least eight consecutive hours in the sleeper berth, plus two consecutive hours either in the sleeper berth, off duty, or any combination of the two."³² The new short haul provisions for the 2005 rule were as follows:

27. *Id.*

28. *Pub. Citizen*, 374 F.3d at 1216.

29. FMCSA, HOURS-OF-SERVICE REGULATIONS - EFFECTIVE OCTOBER 1, 2005 (2005), available at <http://www.fmcsa.dot.gov/rules-regulations/topics/hos/HOS-2005.htm> (last visited Feb. 17, 2006).

30. Laux, *supra* note 26.

31. 49 C.F.R. § 395.3 (2005).

32. FMCSA, *supra* note 29.

Drivers of property-carrying CMVs which do not require a Commercial Driver's License for operation and who operate within a 150 air-mile radius of their normal work reporting location:

- May drive a maximum of 11 hours after coming on duty following 10 or more consecutive hours off duty.
- May not drive after the 14th hour after coming on duty 5 days a week or after the 16th hour after coming on duty 2 days a week.³³

2. *Regulatory Activity in the Rail Transportation Industry*

Sussman and Coplen conducted an in-depth review of the history of the U.S. Hours of Service Act, which was originally enacted in 1907 and substantially revised in 1969 (and formerly codified at 45 United States Code Sections 61-64b).³⁴ According to Sussman and Coplen, the Act was “intended to promote the safety of employees and travelers upon railroads by limiting the hours of service of certain railroad employees.”³⁵ Section 2 of the Act made it “[u]nlawful for a common carrier, its officers, or agents to require or permit ‘an employee’ to go, or remain on, duty unless certain restrictions on maximum duty hours and minimum periods off duty were met.”³⁶ Section 3 states that “no operator, dispatcher, or other employee” engaged in ‘train order service’ could be required, or permitted to go, or remain, on duty in violation of specific limitations.³⁷ Sussman and Coplen summarized the regulations as follows:

For “train and engine service,” a railroad carrier and its officers and agents may not require or allow an employee to remain or go on duty after 12 continuous hours on duty, or 12 hours in broken service in a 24-hour period starting at beginning of work tour; or at the end of that 24-hour period, if there has not been at least eight consecutive hours of off-duty time even if the employee had fewer than 12 hours on duty. The minimum off-duty periods are eight or 10 consecutive hours, depending on whether 12 continuous hours were worked. There is a 4-hour minimum for interim rest period. . . .³⁸

Similarly, they wrote “[f]or ‘signal service,’ where employees are engaged in installing, maintaining, or repairing signal systems, limitations and minimum off-duty periods are generally the same as ‘train and engine service,’ but better defined in statute.”³⁹ Due to basic differences in the nature of service, there are unique provisions, the most important of

33. *Id.*

34. Sussman et al., *supra* note 1.

35. *Id.*

36. *Id.*

37. *Id.*

38. *Id.*

39. *Id.*

which are concerned with trouble calls.⁴⁰ With regard to off-duty time, at least thirty minutes and up to sixty minutes of return travel count as time off duty, but this brief period does not break continuity of duty.⁴¹ Rather, release periods of “more than one hour” are considered to break continuity.⁴²

And finally, “[f]or ‘train order service,’ where an employee transmits or receives orders pertaining to or affecting train movements (especially dispatchers and operators), work must cease after: nine hours on duty in any twenty-four-hour period where two or more shifts are employed; or 12 hours in one-shift operation.”⁴³ “There is an exception of four extra hours for an emergency, but no more than three times in a seven-day period.”⁴⁴

In 1992, Congress enacted the Rail Safety Enforcement and Review Act.⁴⁵ This Act added additional language such that,

Any person (including but not limited to a railroad; any manager, supervisor, official, or other employee or agent of a railroad; any owner, manufacturer, lessor, or lessee of railroad equipment, track, or facilities; any independent contractor providing goods or services to a railroad; and any employee of such owner, manufacturer, lessor, lessee, or independent contractor) that requires or permits any employee to go, be, or remain on duty in violation of section 2, section 3, or section 3A of this Act, shall be liable for a penalty. . . .⁴⁶

Of all transport modes regulated by the U.S. Department of Transportation, railroad hours-of-service standards are the only ones locked into statute rather than being adjustable by administrative regulation.⁴⁷ Comments by spokespersons from the National Transportation Safety Board have indicated that the current rules are not consistent with scientific knowledge concerning human circadian rhythm, nor do they reflect the operating practices employed in various types of freight or commuter rail service.⁴⁸ The basic standard is eight consecutive hours off duty in the preceding twenty-four hours, or ten consecutive hours off duty after working twelve consecutive hours.⁴⁹

40. *Id.*

41. *Id.*

42. *Id.*

43. *Id.*

44. *Id.*

45. *Id.*

46. *Id.*

47. *Recent Derailments and Railroad Safety: Hearing Before the H. Subcommittee on Railroads*, 107th Cong. (2002), available at <http://www.house.gov/transportation/rail/06-06-02/06-06-02memo.html> (last visited Oct. 3, 2006).

48. *Id.*

49. *Id.*

The current hours-of-service rules are now also embedded in the rail carriers' crew-calling system and the union pay-scale structure.⁵⁰ Crew-calling is the procedure by which operating crewmembers are required to be available for duty and by which they are actually called to report for duty.⁵¹ The NTSB has previously pointed out that rail carriers have become accustomed to the current crew-calling system and see the system as a way of keeping excess crews to a minimum.⁵² The operating crew pay scales reflect pay premiums for additional work based on the existing standards of the Hours of Service Act.⁵³ The NTSB has previously testified that this gives senior employees an incentive to work more hours than they should in order to maximize total pay.⁵⁴

In a recent discussion of the current situation, former Federal Railway Administrator Allan Rutter argued that even if these restrictions are observed, train crews can work an enormous number of hours in a week, month, or year.⁵⁵ While commuter train crews may have some predictability in their work schedules, crews of road trains rarely do.⁵⁶ The long hours, irregular work and rest cycles, and lack of regular days off combine to have a very deleterious effect on employee alertness.⁵⁷

3. Regulation in Canada

Other countries have also attempted to address these hours of service issues. Most recently, Canada issued and adopted a new approach to the HOS for railroads that both limits time-on-duty and mandates the implementation of Fatigue Management Plans.⁵⁸ The European Union has also addressed these issues.⁵⁹

Following a lengthy two-year process the Canadian Railroads and its labor organizations responded to a directive from the Ministry of Transportation that Canadian operating employees in road, yard or passenger service are permitted to work for a maximum of twelve continuous hours

50. *Id.*

51. *Id.*

52. *Id.*

53. *Id.*

54. *Id.*

55. *Recent Derailments and Railroad Safety: Hearing Before the H. Subcommittee on Railroads*, 107th Cong. (2002) (statement of Allan Rutter, Administrator, Fed. Railway Admin.), available at <http://www.house.gov/transportation/rail/06-06-02/rutter.html> (last visited Oct. 3, 2006).

56. *Id.*

57. *Id.*

58. See generally Transport Canada, *Work/Rest Rules for Railway Operating Employees* (June 2005), available at http://www.tc.gc.ca/railway/Rules/TC_O_0_50.htm (last visited Oct. 3, 2006) (establishing mandatory work and rest rules for the Canadian rail industry).

59. See Council Directive 2000/34, art. 1, 2000 O.J. (L 195) 41.

during a single tour of duty.⁶⁰ The Work/Rest Rules were developed “pursuant to section 20 (1) of the Railway Safety Act, R.S. 1985, c.32 (4th Supp).”⁶¹ There are a number of relevant provisions in this Act. A few key provisions are listed below:

5.1.1 The maximum continuous on-duty time for operating employees performing one tour of duty is:

- a. 12 hours operating freight trains in road service;
- b. 12 hours operating passenger trains in intercity or commuter service;
- c. 16 hours operating trains in work train service; and
- d. 12 hours for one tour of duty in yard service.

5.1.2 The maximum on-duty time for operating employees working more than one tour of duty is 18 hours in any 24-hour period except as otherwise provided in section 5.1.3

5.1.3 The maximum on-duty time for operating employees working more than one tour of duty in yard service is 16 hours in any 24-hour period.

5.1.4 When an operating employee works more than one class of service in a 24-hour period, the class of service for which the employee is being called will determine the maximum on-duty time available to that person.

5.1.5 In calculating maximum available hours remaining in the 24-hour period for the purposes of paragraphs 5.1.2. and 5.1.3, 6 hours continuous off-duty time is required to ‘reset’ the clock to zero.

5.2.1 Operating employees who go off-duty after being on-duty in excess of 10 hours will:

- a. at the home terminal - be subject to at least 8 hours off-duty, exclusive of call time, except for yard service employees returning to their regular shift, who will be subject to at least 6 hours off-duty, exclusive of call time, where applicable; and
- b. at the away-from-home terminal - be subject to at least 6 hours off-duty, exclusive of call time.

5.2.2 When the on-duty time for one trip is less than or equal to 10 hours and the off-duty time between trips is less than 3 hours, the total on-duty time for consecutive trips will be combined for the purpose of calculating mandatory off-duty time. The off-duty time between such trips is not included in the calculation of total on-duty time.

6.1.1 Railways will implement fatigue management plans.

6.1.2 Fatigue management plans shall be designed to reduce fatigue and improve on-duty alertness of operating employees.

6.1.3 Fatigue management plans shall reflect the nature of the operations under consideration, including work trains on a particular territory, taking into account such items as size, complexity, traffic density, traffic patterns, run length and geographical considerations.

6.2.2 Fatigue management plans must consider but not be limited to the following:

- a. employee work scheduling practices;

60. Transport Canada, *supra* note 58, at § 5.1.

61. *Id.* at § 3.

- b. education and training;
- c. on the job alertness strategies;
- d. rest environments;
- e. work environments;
- f. working under unusual operating conditions;
- g. unique deadheading circumstances.

6.2.3 Fatigue management plans must address how operating employees, who work more than one tour of duty in any 24-hour period, will be afforded the opportunity to be involved in the decision to accept a subsequent tour of duty, based on their fitness at that time.

6.2.4 A specific fatigue management plan must be in place to address fatigue of operating employees in the following circumstances:

- a. where continuous on-duty hours exceed 12 hours;
- b. where there are more than 64 hours on-duty in a 7 day period; and
- c. emergency situations.⁶²

These rules are a major step forward for the Canadian rail industry. Combined with the required Fatigue Management Plans,⁶³ these rules establish both a prescriptive and a non-prescriptive approach to managing fatigue.⁶⁴

C. HIGH PROFILE CASES

Ordinarily, societal pressure to address HOS issues emerges following high profile accidents or incidents in the transportation industry. Several such accidents leading to injury and death have occurred in the last few years which have contributed to the general concern that there may need to be some changes in the way that transportation systems – in particular rail and trucking systems - are operated.⁶⁵ Following a series of railroad car derailments in 2002, the House Subcommittee on Rail held hearings that addressed derailments and explored issues concerning hours of service.⁶⁶ A number of derailments in 2004 in Texas have also raised concern about fatigue issues.⁶⁷ These high profile incidents have created concerns that the human operators of the vehicles may have been overly fatigued when they were operating their vehicles.

In a case involving the rear-end collision of three Union Pacific freight trains, the National Transportation Safety Board determined that the probable cause of the accident “was the conductor and engineer of train CNRBW-10 being in a fatigue-induced unresponsive state as their

62. Transport Canada, *supra* note 58.

63. *Id.* at §§ 6-7.

64. *See generally, id.*

65. *See generally Hearing Before the H. Subcommittee on Railroads, supra* note 47.

66. *See id.*

67. *See* Dan Weikel, *Rising Pressures Cause Deadly Human Errors on Trains*, L.A. PILOT, Apr. 27, 2005, <http://www-scf.usc.edu/~tkelley/features.html> (last visited Oct. 4, 2006).

train passed several wayside signals and approached the rear of train 2CNAAE-10.”⁶⁸ Similarly, the NTSB noted that the probable cause of the collision and derailment of two Union Pacific trains near Des Plaines Illinois was the result of

... the train MPRSS-21 engineer’s falling asleep at the controls of his locomotive and the unexplained inattentiveness and inaction of the conductor in the moments before the collision. Contributing to the engineer’s falling asleep was likely his use of prescription medications that may cause drowsiness, as well as his lack of sleep in the 22 hours preceding the accident.⁶⁹

The NTSB also investigated an accident near Clarkson, Michigan, and found that the probable cause of the November 15, 2001 Canadian National/Illinois Central Railway incident, was “crewmembers’ fatigue, which was primarily due to the engineer’s untreated and the conductor’s insufficiently treated obstructive sleep apnea.”⁷⁰

More recently, a major accident occurred in June 2004 in San Antonio, Texas. The collision involved a Union Pacific (UP) freight train and a Burlington Northern Santa Fe (BNSF) freight train.⁷¹ According to the NTSB, the UP crew had gone on duty in San Antonio at 2:45 a.m. and had been on duty approximately two hours and eighteen minutes at the time of the collision.⁷² Prior to the accident, the UP engineer had been off duty for fourteen hours, and the conductor had been off duty for almost twenty-eight hours.⁷³ The impact of the collision caused the derailment of thirty-five freight cars, four locomotives and the release of chlorine from the tank cars.⁷⁴ The collision caused the death of the UP conductor and two residents of the community near the site of the derailment, while the resulting large chlorine cloud lead the death of two additional residents and treatment of more than forty people at local hospitals.⁷⁵ Local government officials, urged to action by the public, have called for a major review of the safety operations of the railroad in

68. NTSB, RAILROAD ACCIDENT BRIEF, RAB-04/06 (June 17, 2004), <http://www.nts.gov/publicn/2004/RAB0406.htm> (last visited Oct. 4, 2006).

69. NTSB, RAILROAD ACCIDENT BRIEF, RAB-04/04 (May 27, 2004), <http://www.nts.gov/publicn/2004/RAB0404.htm> (last visited Sept. 8, 2006).

70. NTSB, RAILROAD ACCIDENT REPORT, RAR-02/04 (Nov. 15, 2001), <http://www.nts.gov/publicn/2002/RAR0204.htm> (last visited Oct. 4, 2006).

71. NTSB, SECOND UPDATE ON NTSB INVESTIGATION OF RAIL COLLISION NEAR SAN ANTONIO, TEXAS (Aug. 27, 2004), <http://www.nts.gov/Pressrel/2004/040827.htm> (last visited Oct. 4, 2006).

72. *Id.*

73. *Id.*

74. NTSB, COLLISION OF UNION PACIFIC RAILROAD FREIGHT TRAIN MHOTU-23 AND BNSF RAILWAY COMPANY FREIGHT TRAIN MEAPTUL-126D (June 28, 2004), <http://www.nts.gov/Events/2005/Macдона/default.htm> (last visited Oct. 4, 2006).

75. *Id.*

their area.⁷⁶ The incident has also strengthened the case for reviewing and modifying outdated HOS service regulations.⁷⁷

D. 24/7 OPERATION

Fatigue of rail employees is always a concern due to the continuous 24/7 nature of railroad operations. While the human organism requires sleep, the railroad industry functions twenty-four hours a day, seven days a week. Rail has become an increasingly visible and integral component of the overall transportation system and has acquired a pivotal significance following September 11 with respect to safety and security measures. Rail transit was particularly essential when air traffic was grounded in the days following the World Trade Center dilemma. The West Coast dockworkers strike in 2002 and the increase in trade with China and South East Asia have generated an even greater demand for safe and reliable freight transportation. Due to the steady growth in trade and economic development throughout the world, inbound containers to the U.S. in 2005 were up by 6.7% after surging over 16% in 2004.⁷⁸ Moreover, freight demand has been growing steadily for major U.S. railroads with container traffic 8.3% higher in 2005 than 2004.⁷⁹ In addition, train tonnage per movement has increased dramatically over the last five years from an average of 2,870 tons in 1995⁸⁰ to 3,005 tons in 2001.⁸¹ While both the traffic and workload of the nation's freight railroads have increased, the number of railroad employees has decreased over the last few years – the drop in the number of craft operating employees has been particularly significant.⁸² Recent reports suggest that some railroads are experiencing difficulty moving trains as a result of chronic crew shortages.⁸³ According to the Surface Transportation Board, while container traffic has climbed by 8.3% in recent years, the number of train and engine crewmembers employed by Class I railroads rose to only

76. See generally NTSB, RAILROAD ACCIDENT BRIEF, RAR-06/03 (June 28, 2004), <http://www.ntsb.gov/Publictn/2006/RAR0603.pdf> (last visited Oct. 4, 2006).

77. See *id.*

78. Adam Aston et al., *From Choked Ports, Pricier Products*, BUSINESSWEEK.COM, May 9, 2005, http://www.businessweek.com/magazine/content/05_19/b3932126.htm (last visited Oct. 4, 2006).

79. Railway Age, *Industry Indicators*, 206 RAILWAY AGE 1 (Dec. 2005).

80. U.S. GENERAL ACCOUNTING OFFICE (GAO), FEDERAL RAILROAD ADMINISTRATION'S NEW APPROACH TO RAILROAD SAFETY 17, GOA/RCED-97-142 (1997), available at <http://www.gao.gov/archive/1997/rc97142.pdf> (last visited Oct. 4, 2006).

81. U.S. FEDERAL RAILROAD ADMINISTRATION (FRA), BALTIMORE'S RAILROAD NETWORK: CHALLENGES AND ALTERNATIVES 3-22 (2005), available at <http://www.fra.dot.gov/download/RRDev/brn1.pdf#search=%22train%20tonnage%20%223005%20tons%22%20movement%22> (last visited Oct. 4, 2006).

82. GAO, *supra* note 80, at 19-20.

83. *Id.*

68,799 in September 2005, a 5.19% increase over September 2004.⁸⁴ At the same time, the railroad industry's workforce is aging significantly (average age over forty) which may raise specific concerns and needs with regard to workplace related fatigue and injuries.⁸⁵ Thus, the increased tonnage, decreased number of train crews, and the unknown factors associated with an ageing workforce may be setting the stage for an increase in the risk of fatigue-related accidents. Of concern to the Federal Railroad Administration is the fact that accidents attributed to human factors, of which fatigue plays an undetermined role, have remained fairly constant at nearly thirty-eight percent in comparison to all other causes of accidents such as those relating to mechanical issues, signals problems, or tracks.⁸⁶

E. SCHEDULES

In order to meet the demand for freight rail traffic, labor organizations and rail carriers in the United States have devised flexible work scheduling systems. Following deregulation of the rail industry with the Staggers Act of 1970, the U.S. rail freight industry has seen unprecedented growth and steady financial returns. Accordingly, both labor and management are reluctant to institute changes that could curtail productivity and threaten continued growth.

Work schedules in this freight industry vary considerably, ranging from yard switching and assigned jobs with regular start times to pool assignments with variable start times. In yard and assigned jobs, employees usually come to work at specific times such as 7:00 a.m. or 3:00 p.m. and work typical eight, ten, or twelve-hour shifts. These jobs generally encompass six or seven workdays a week, and include specific tasks such as delivery or pick up at local merchants.

Another type of work assignment frequently found in the freight industry is referred to as the "pool" crew.⁸⁷ Employees bid to be listed on a

84. Institute Shipping Economics and Logistics, *Monthly Container Port Monitor* (July-September 2005), http://www.isl.org/products_services/publications/pdf/MCPM_3rd_quarter_2005_sum.pdf (last visited Oct. 4, 2006); Railway Age, *Late Breaking Rail Industry News: Operating-Crew Numbers Rise* (Nov. 16, 2005), http://www.railwayage.com/breaking_news_archive.shtml (last visited Oct. 4, 2006).

85. See generally Clark Martin, *Help Wanted-Meeting the Need for Tomorrow's Transportation Work Force*, PUBLIC ROADS (July/Aug. 2001), available at <http://www.tfrc.gov/pubrds/julaug01/helpwanted.htm> (last visited Oct. 4, 2006).

86. FRA, FEDERAL RAILROAD ADMINISTRATION ACTION PLAN FOR ADDRESSING CRITICAL RAILROAD SAFETY ISSUES 3 (May 2005), available at http://www.fra.dot.gov/downloads/Safety/action_plan_final_051605.pdf (last visited Oct. 4, 2006).

87. PATRICK SHERRY, FATIGUE COUNTERMEASURES IN THE RAILROAD INDUSTRY: PAST AND CURRENT DEVELOPMENTS 119 (Intermodal Transp. Inst. ed., Ass'n Am. R.R. 2000), available at <http://www.du.edu/transportation/Resources/pdfs/fatigue.pdf> (last visited Sept. 22, 2006).

board which has a predetermined number of positions or “turns.”⁸⁸ The persons on the board are assigned to a job typically by using a “first-in first-out” system.⁸⁹ As each person on the board is called for work, the next person in line advances until the end is reached and the entire sequence is repeated.⁹⁰ Employees who complete a round trip are placed at the bottom of the board and await the complete cycle of the board before being assigned to a job again.⁹¹ Since freight trains typically operate on an as-needed basis to best serve the needs of the customers, there are few scheduled departure and arrival times.⁹² Thus, call times for employees are unpredictable and provide railroad employees with little certainty regarding when they might realistically depart for work.

The duration of these assignments can range from a few hours to the maximum twelve hours for operating equipment.⁹³ For a variety of reasons, a crew might stop operating its equipment in a remote location rather than a terminal and thus require a relief crew to be transported to that location. Accordingly, in addition to on-duty time there may be significant wait periods before the crew is relieved and transported home or to a hotel. The entire length of the trip can therefore exceed twelve hours and may sometimes be as long as fourteen or even sixteen hours. During periods of high demand, engineers may then need to work between sixteen to even eighteen-hour schedules.⁹⁴ Thus, an engineer may legally work eleven hours and fifty-nine minutes, be given eight hours off, and then return to work resulting in a twenty hour schedule.⁹⁵ Alternatively, an engineer could legally work eight hours and rest for eight hours resulting in a sixteen-hour schedule.⁹⁶

These variable and long work hour schedules benefit both employers and employees alike. The schedules allow rail companies to be more flexible, accommodate their customers, and maximize the use of crew time. These schedules also enhance employee income by providing more paid hours than schedules that are based on a twenty-four hour cycle. However, such schedules create challenges for crews in the form of obtaining needed rest and maintaining a satisfying quality of life. It has been well documented that humans have regular circadian rhythms which regulate the time of sleep onset.⁹⁷ These rhythms are entrained about the normal

88. *Id.* at 46.

89. *Id.* at 119.

90. *Id.*

91. *Id.*

92. *Id.* at 46.

93. *Id.* at 38.

94. *Id.*

95. *Id.* at 8, 38.

96. *See id.*

97. Sussman et al., *supra* note 1.

twenty-four hour diurnal cycle.⁹⁸ Irregular work schedules might therefore seriously limit the ability of an engineer to achieve adequate sleep and may increase the likelihood that railroad workers will be expected to work at times when their bodies are biologically inclined to be less alert.⁹⁹

The situation in rail passenger service is significantly different. The NTSB report describes an example schedule of an employee working for passenger operations as follows:

The motorman of train 509 reported to work overtime duty at 6:28 a.m. and was scheduled to work a split shift. He had worked from 10:00 p.m. to 6:00 a.m. as a switchman before beginning his overtime shift as a motorman. At the end of the first half of the split shift, the motorman had been on duty for approximately 12 hours. He stated that he took about a 3 1/2 hour nap and returned to work at 2:49 p.m. The CTA has an agreement not to schedule back-to-back shift work, but this assignment was not a scheduled position. Because the assignment was offered as a voluntary overtime position, the motorman of train 509 was able to choose to work the back-to-back shifts.¹⁰⁰

F. SUMMARY

The rail industry is characterized by unpredictable work schedules, long hours, and continuous operations. The highly flexible scheduling arrangements and focus on customer service has required flexible start times and long hours. For the most part, crews are on duty in the area of about 9.5 hours.¹⁰¹ However, at peak times employees may be on duty for as many as eighteen hours.¹⁰² Several key high profile accidents have focused attention on fatigue as a contributing factor to the occurrence of accidents. In addition, the success of the freight rail industry has seen increases in both traffic and workload.¹⁰³ The NTSB has cited operator fatigue as a top ten safety concern.¹⁰⁴ The HOS regulations were developed in 1907 and have not been substantially revised since that time.¹⁰⁵ Most experts agree that the current HOS regulations are not consistent with recent developments in the science of sleep and fatigue. Taken together these findings suggest a need to review the current HOS regula-

98. *Id.*

99. *Id.*

100. NTSB, RAILROAD ACCIDENT BRIEF, RAB-04/07 (July 7, 2004), <http://www.nts.gov/publicn/2004/RAB0407.htm> (last visited Oct. 4, 2006).

101. Sherry, *supra* note 87, at 8.

102. Sussman et al., *supra* note 1.

103. See BUS. & CO. RESOURCE CTR., *Industry Indicators*, 207 RAILWAY AGE 1, 1 (2006) (showing U.S. total carloads percentage increased from 2004, thus exemplifying increased workload and traffic).

104. NTSB, *supra* note 3.

105. NTSB, *supra* note 4, at 2.

tions in light of current scientific thinking regarding how best to manage the impact of human fatigue on the safety of the rail transportation system.

II. SCIENTIFIC LITERATURE

A. HOURS ON DUTY/LONG HOURS

The issue of how long a person should work, or for how many hours, is one that has been of concern to workers and regulators for many years. As noted above, efforts to restrict the number of consecutive hours that a person could safely work were addressed with the Hours of Service Act of 1907.¹⁰⁶ Research addressing the effect of long periods of time awake on cognitive performance has been conducted to help understand this vexing problem.

A now classic study by Angus, Heslegrave, and Myles found that significant reductions in mood and performance were observed over time for a sample of twelve male university students undergoing sixty hours of sleep deprivation.¹⁰⁷ While this is not a work hours study *per se*, the study participants were awake for long periods of time and analogously demonstrated the relationship between long hours awake without sleep and the effects of long hours at work on performance.¹⁰⁸ Shortly thereafter, a study by Jones and Stein found that the relative risk of crash involvement for drivers who reported a driving time in excess of eight hours was almost twice that for drivers who had driven fewer hours.¹⁰⁹ Later research by Rosa and Colligan found that performance errors increased after four days on a twelve-hour schedule.¹¹⁰ More recently, Rosa, Bonnet, and Cole examined the effects of twelve-hour versus eight-hour work schedules on fatigue in the upper body. Results of the study of sixteen participants indicated that fatigue increased with time on shift and that fatigue occurred more quickly on night shifts.¹¹¹

The Driver Fatigue and Alertness Study (DFAS) conducted by the U.S. Department of Transportation showed that several measures of alertness were lower at the end of trips than they were at the start.¹¹² The

106. *Id.*

107. Robert G. Angus et al., *Effects of Prolonged Sleep Deprivation, with and without Chronic Physical Exercise, on Mood and Performance*, 22 *PSYCHOPHYSIOLOGY* 276, 276-77 (1985).

108. *See id.* at 276 (for discussion of decrease in performance due to extended sleep loss).

109. JONES & STEIN, *EFFECT OF DRIVER HOURS-OF-SERVICE ON TRACTOR-TRAILER CRASH INVOLVEMENT* (Ins. Inst. for Highway Safety 1987).

110. Roger R. Rosa & Michael J. Colligan, *Long Workdays versus Restdays: Assessing Fatigue and Alertness with a Portable Performance Battery*, 30 *HUM. FACTORS* 305, 305, 311 (1988).

111. Roger R. Rosa et al., *Work Schedule and Task Factors in Upper-Extremity Fatigue*, 40 *HUM. FACTORS* 150, 150 (1998).

112. *See WYLIE ET AL.*, *COMMERCIAL MOTOR VEHICLE DRIVER FATIGUE AND ALERTNESS*

DFAS also showed that driver self-reports of fatigue had a strong relationship with elapsed time since trip start.¹¹³ Even though these self-reports were different from objective measurement outcomes, it was concluded that the reports may indicate that increasing stress levels can be traced to fatigue, and that the self-reporting drivers had diminished motivation and ability to remain alert by the end of their trips.¹¹⁴

O'Neill, Kruegar, Van Hemel, and McGowan studied ten male commercial motor vehicle drivers for one week of driving operations in a simulator, followed by fifty-eight hours of recovery time.¹¹⁵ This was followed by another week of driving, fifty-eight hours of recovery time and a final driving day to verify performance after recovery.¹¹⁶ The drivers worked fourteen hours on duty (i.e. twelve hours driving plus scheduled breaks) beginning at 7:00 a.m., followed by ten hours off duty.¹¹⁷ Among other discoveries, this study revealed a gradual decline in driver response quality, as measured by response probes, with hours of driving.¹¹⁸ There were improvements after each break regardless of whether the breaks were for resting, eating, or loading activities.¹¹⁹ Throughout the driving week, there was a slight but statistically significant deterioration in subjective sleepiness, reaction time response, and measures of driving performance over each working day.¹²⁰ However, "driver response in crash-likely situations did not show cumulative deterioration."¹²¹ The daytime-oriented "schedule of 14 hours on duty/10 hours off duty (12 hours driving) for a 5-day week did not appear to produce significant cumulative fatigue over the 2-week testing period."¹²² This study shows that long work hours (such as fourteen hours), during daylight hours with appropriate breaks do not necessarily result in significant degradation of performance.

STUDY: PROJECT REPORT 9 (U.S. Dep't of Transp. Fed. Highway Admin. Nov. 1996, Transp. Can. Oct. 1996) (Nov. 1996), *microformed on* TD 2.30/14:97-002 (Microfiche) (reporting decreased tracking performance, cognitive performance and increased fatigue over days of driving).

113. *See id.* at 9, 13 (reporting drivers possibly have an increased feeling of fatigue as they work longer hours).

114. *See id.* at 13 (discussing increased stress versus objective performance).

115. FED. HIGHWAY ADMIN., EFFECTS OF OPERATING PRACTICES ON COMMERCIAL DRIVER ALERTNESS 2 (Fed. Highway Admin. 1999), *microformed on* TD 2.30/20:99-008 (Microfiche).

116. *See id.* (discussing week two, fifty-eight hours for recovery time and day of verification of performance after recovery).

117. *Id.* at 1 (describing the exact driver performance on/off schedule).

118. *Id.* at 3-4 (describing that later in the day drivers experienced decreased physical coordination and vigilance).

119. *Id.* at 3 (describing overall improvement in performance after each break).

120. *Id.* (describing the statistically significant decline in responses and performance over each work day).

121. *Id.* (describing no deterioration in driver response in "crash-likely" situations).

122. *Id.* (describing a schedule that did not result in a significant fatigue effect).

Four studies reported in a recent review of the literature by the Centers for Disease Control (CDC) discussed deterioration in performance when twelve-hour shifts were combined with more than forty hours work per week. Novak and Auvil-Novak reported an unexpected outcome from focus groups with nurses who worked four twelve-hour night shifts per week: nearly all nurses reported an automobile crash or near-miss during the previous twelve months while driving home after working a twelve-hour night shift.¹²³ However, the nurses reported no job performance effects when they maintained consistent sleep and wake times - but changing from night work to day activities was fatiguing and affected performance.¹²⁴

In a field study, Fischer et al. examined the second, sixth, and tenth hours of twelve-hour shifts in Brazilian petrochemical plant workers and reported a significant decline in subjective alertness at the tenth hour for both day and night shifts.¹²⁵ Similarly, Mitchell and Williamson reported more vigilance task errors at the end of twelve-hour day and night shifts when compared to the beginning of the shifts in Australian power plant workers, while no effect was reported for an eight-hour schedule.¹²⁶ On the other hand, significant improvements were observed for simple reaction time and grammatical reasoning tests given at the end of the twelve-hour shift when compared to the beginning.¹²⁷ Although Duchon et al. reported no differences between eight and twelve-hour shifts on cognitive and psychomotor performance in Canadian mine workers, the heart rate findings suggest that the twelve-hour workers slowed the pace of their work.¹²⁸ Thus, there appears to be a reduction in performance by the end of a twelve-hour shift suggesting that twelve hours may be approaching an upper limit of acceptable performance in the workplace.¹²⁹

Looking at the results of several studies, Akerstedt concluded that there is a steady linear decline of approximately 2.4% per hour in cogni-

123. Novak & Auvil-Novak, *Focus Group Evaluation of Night Nurse Shiftwork Difficulties and Coping Strategies*, 13 *CHRONOBIOLOGY INT'L* 457 (1996).

124. *See id.*

125. Frida Fischer et al., *Implementation of 12-Hour Shifts in a Brazilian Petrochemical Plant: Impact on Sleep and Alertness*, 17(4) *CHRONOBIOLOGY INT'L* 521, 525, 529 (2000).

126. *See* Rebecca J. Mitchell & Ann M. Williamson, *Evaluation of an 8 Hour versus a 12 Hour Shift Roster on Employees at a Power Station*, 31 *APPLIED ERGONOMICS* 83, 89-91 (2000) (implying that there is not an increase in vigilance errors in an eight hour work shift because workers' performance increased at the end of their shifts).

127. *Id.* at 89.

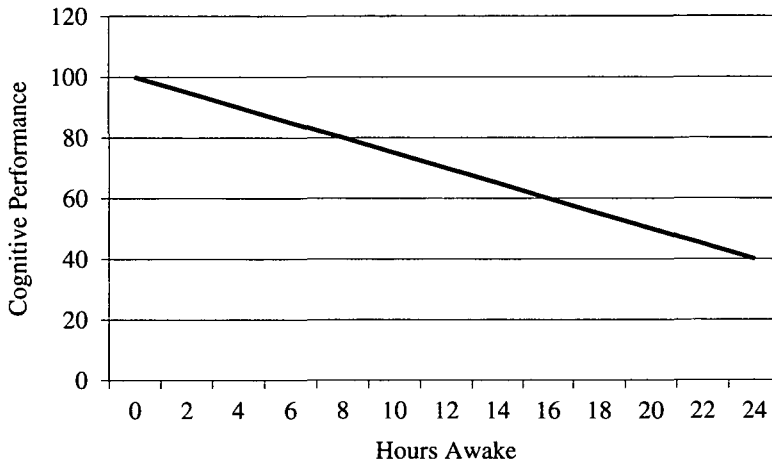
128. James C. Duchon et al., *Physiological Manifestations of Performance during Work on Extended Workshifts*, 20 *INT'L J. INDUS. ERGONOMICS* 39, 39 (1997).

129. *See* Mitchell & Williamson, *supra* note 126, at 83 (arguing that higher error rate at the end of a twelve hour shift correlates to approaching an upper limit of acceptable work performance).

tive performance over time.¹³⁰ While many factors such as time of day, caffeine use, and motivation, affect this rate, the rate can serve as a crude estimate of the effects of sleep deprivation.¹³¹

Following this model then, we would estimate that performance declines to about 25% of baseline at around ten to eleven hours of wakefulness or about 40% by the end of a sixteen hour day. This would suggest that an upper limit on the number of hours a person should work in a given day would not exceed sixteen hours. More conservatively, we would not expect a person to be engaged in operations requiring considerable cognitive input to last more than ten or eleven hours maximum.

ESTIMATED DECLINE IN PERFORMANCE OVER HOURS
OF WAKEFULNESS



Optimal performance, which of course will vary depending upon the type of task that an individual is engaged in, will require higher levels of cognitive capacity. As can be seen from the above hypothetical graph, performance declines steadily, and after eight hours performance is nearly 20% off baseline or 80% effectiveness. Thus, assuming that performance of basic cognitive tasks is expected to be no less than about 80% of optimal performance then an eight or ten hour day would be desired.

Driving, which requires sustained attention and in which even short lapses of attention of one or two seconds can be fatal, would seem to require shorter durations.¹³² Railroad operations have sufficient redun-

130. TORBJORN AKERSTEDT, *WIDE AWAKE AT ODD HOURS: SHIFTWORK, TIME ZONES, AND BURNING THE MIDNIGHT OIL* (Swedish Council for Work Life Research 1996).

131. Sherry, *supra* note 87, at 77-78.

132. See Christopher A. Monk, *Recovering from Interruptions: Implications for Driver Dis-*

dancies and safeguards such that lapses of one or two seconds may not generally result in catastrophic consequences.¹³³

Some studies have examined the combination of long work hours accumulated over the course of an extended time period, such as a work-week. For example, Lipscomb et al. compared the usual five eight-hour shifts to a combination of twelve-hour shifts and forty or more hours of work a week.¹³⁴ Their results indicated that study participants in the twelve-hour shifts had a greater chance of neck, shoulder, and back disorders compared to five eight-hour shifts per week.¹³⁵ In contrast, Mitchell and Williamson reported fewer health complaints during a twelve-hour day/night fast forward rotation when compared with an eight-hour three-shift weekly backward rotation.¹³⁶

Twelve-hour shifts are popular among some shift workers due to the perceived improvements in lifestyle and leisure time availability. Findings reviewed and summarized in the CDC¹³⁷ support the benefits of twelve-hour shifts in that there were no significant differences found between (a) eight and twelve hour shifts in nuclear power plant workers;¹³⁸ (b) four ten-hour shifts versus five eight-hour shifts on cognitive performance tests for air traffic controllers; (c) eight and twelve hour shifts in Swedish power plant workers on simple reaction time and vigilance;¹³⁹ and (d) no difference in reaction time on workers switching between eight-hour and twelve hours shifts.¹⁴⁰ These results suggest that indeed, shifts of twelve hours in length may not present any noticeable perform-

traction Research, 46 HUMAN FACTORS 650, ¶ 3 (2004) (citing to Ranney, *Models of Driving Behavior: A Review of Their Evolution*, 26 ACCIDENT ANALYSIS & PREVENTION 755 (1994)).

133. See Matthew L. Wald, *Faster Amtrack Trains, Fancier Safeguards*, N.Y. TIMES, May 21, 2000 sec. Travel Desk at 3 (explaining new safety equipment installed to prevent railroad accidents).

134. Jane A. Lipscomb et al., *Work-Schedule Characteristics and Reported Musculoskeletal Disorders of Registered Nurses*, 28 SCANDINAVIAN J. WORK ENV'T HEALTH 394 (2002).

135. *Id.*

136. See Mitchell & Williamson, *supra* note 126, at 86 (discussing health complaints); Cf. Lawrence Smith ET AL., *Work Shift Duration: A Review Comparing Eight Hour and 12 Hour Shift Systems*, 55 OCCUPATIONAL & ENVTL. MED. 217, 218 (1998).

137. See CLAIRE C. CARUSO ET AL., *OVERTIME AND EXTENDED WORK SHIFTS: RECENT FINDINGS ON ILLNESSES, INJURIES, AND HEALTH BEHAVIORS* (NIOSH Publications Dissemination, Publication No. 2004-143, 2004).

138. See *id.* (citing to Smith et al., *Shiftwork Effects in Nuclear Power Workers: A Field Study using Portable Computers*, 9(2-3) WORK STRESS 235 (1995)).

139. John Axelsson et al., *Effects of Alternating 8- and 12-Hour Shifts on Sleep, Sleepiness, Physical Effort and Performance*, 24 SCANDINAVIAN J. WORK ENV'T HEALTH 62 supp. 3 at 63, 67 (1998).

140. Arne Lowden et al., *Change from an 8-Hour Shift to a 12-Hour Shift, Attitudes, Sleep, Sleepiness, and Performance*, 24 SCANDINAVIAN J. WORK ENV'T HEALTH 69 supp. 3 at 69, 74 (1998).

ance problems.¹⁴¹ However, it should be noted that these tend to be regularly scheduled shifts with regular start times, not the variable start times typically found in the railroad industry.¹⁴²

A recent analysis of the National Longitudinal Survey of Youth examined the shift length, number of hours worked per day and week and the health and safety histories of over 10,793 U.S. workers from 1987 to 2000.¹⁴³ The study employed various multivariate analyses to estimate the relative risk of exposure to long working hours per day, extended hours per week, and overtime on reported work related injury or illness.¹⁴⁴ Results of the study revealed that individuals working in jobs with overtime had a 61% higher rate of injury as compared to those without overtime.¹⁴⁵ In addition, it was found that persons working at least a twelve hour day was associated with a 37% increased rate of injury and working at least sixty hours per week was associated with a 23% increased rate of injury or illness.¹⁴⁶ These findings, based on very large samples, are consistent with the hypothesis of a “dose-effect” such that the greater the amount of time worked, the greater the risk of injury or illness.¹⁴⁷ While these data are based on self-reported information, they are consistent with other studies finding similar results and raise the issue of the need to address long hours and overtime as potentially hazardous working conditions.¹⁴⁸ Interestingly, in a recent comparison of backward rotating eight hour shifts with forward rotating ten hour shifts, results showed that the ten-hour nightshift workers self-report indicated more refreshing sleep and fewer performance impairments and driving difficulties than eight-hour nightshift workers.¹⁴⁹ Moreover, objective measures of sleep and performance on the ten-hour nightshifts were similar or greater than those of the ten-hour dayshifts.¹⁵⁰ The authors noted that

141. CARUSO ET AL., *supra* note 137, at 17 (describing four studies reporting no differences in work performance).

142. *See generally id.* at 18, 20 tbl.7 (exemplifying results from the studies based on regularly scheduled shifts).

143. Dembe et al., *The Impact of Overtime and Long Work Hours on Occupational Injuries and Illnesses: New Evidence from the United States*, 62 OCCUPATIONAL ENVTL. MED. 588, 588 (2005).

144. *Id.* (explaining the study employed a multivariate analysis).

145. *Id.* at 588, 594 (explaining the higher results of injury to individuals from working overtime versus those not working overtime).

146. *Id.* at 588, 592 (discussing percentages of increased hazard rate).

147. *Id.* at 588 (explaining that a “dose-response” effect occurs with the increased susceptibility to injury with increased number of hours worked).

148. *See id.* at 595 (discussing that the study produced a valid and objective outcome despite self-report limitations).

149. Jamil L. Hossain et al., *Subjective and Objective Evaluation of Sleep and Performance in Daytime Versus Nighttime Sleep in Extended-Hours Shift-Workers at an Underground Mine*, 46 J. OCCUPATIONAL ENVTL. MED. 212, 212, 220-21 (2004).

150. *Id.* at 212, 221.

their data suggests that shorter nightshifts could be more beneficial to shift-workers and employers.¹⁵¹

The findings discussed above reveal a direct relationship between non-sleep hours and performance decreases. Nevertheless, as some studies point out, certain types of twelve-hour shifts may still be beneficial if properly designed. The current maximum duty time recommended by the HOS is therefore not inconsistent with the scientific literature.

B. SLEEP DEPRIVATION

Following the Angus, Heslegrave, and Myles report, numerous studies began to examine the effects of sleep deprivation on performance.¹⁵² A review of the literature on sleep deprivation and performance by Pilcher and Huffcutt found that a person's reaction time increases as the number of waking hours increases, while overall cognitive performance decreases.¹⁵³ Summarizing data from nineteen original research studies, meta-analytic results reveal that sleep deprivation is negatively correlated with human performance.¹⁵⁴ Chronic and partial sleep deprivation or restrictions (less than five hours of sleep per night over a number of days) degraded performance more than either acute short-duration total sleep deprivation (less than or equal to forty-five hours) or long-duration total sleep deprivation (greater than forty-five hours).¹⁵⁵ The authors noted that partial sleep deprivation had a much stronger overall effect on the dependent measures than either short-duration or long-duration total sleep deprivation.¹⁵⁶ Specifically, participants in partial sleep-deprivation conditions performed *two standard deviations below the mean of normal non-sleep* deprived study participants compared to approximately one standard deviation for either short or long-duration total sleep deprivation.¹⁵⁷

Sleep deprivation results in decrements on many cognitive tasks.¹⁵⁸ In a study of eighteen right-handed males deprived of sleep for twenty-four hours,¹⁵⁹ the researchers found no effects on freedom from distractibility, tactile functions, visual function, reading, writing, arithmetic, and

151. *Id.* at 221.

152. R.G. Angus et al., *Effects of Prolonged Sleep Deprivation, With and Without Chronic Physical Exercise, on Mood and Performance*, 22 *PSYCHOPHYSIOLOGY* 276, 276-277 (1985).

153. J.J. Pilcher & AI Huffcutt, *Effects of Sleep Deprivation on Performance: A-Meta Analysis*. 19 *SLEEP* 318, 323-324 (1996).

154. *Id.* at 320.

155. *Id.* at 319.

156. *Id.* at 322.

157. *Id.* at 324.

158. D. Kim et al., *The Effect of Total Sleep Deprivation on Cognitive Functions in Normal Adult Male Subjects*, 109 *INT'L J. OF NEUROSCIENCE* 127, 127, 133 (2001).

159. *Id.* at 129.

intellectual process functions.¹⁶⁰ However, cognitive functions such as motor, rhythm, receptive and expressive speech, memory, and complex verbal arithmetic functions decreased after sleep deprivation.¹⁶¹ A review of several studies showed that losses in cognitive performance of nearly 30% occurred after one night and 60% after two nights of sleep loss.¹⁶²

There may be some interesting individual differences in ability to handle long work hours and sleep deprivation. A laboratory study of twelve-hour shifts found that older participants performed more poorly than younger participants over the duration of the shifts on tests of cognitive performance.¹⁶³ These results may have some implications for the railroad industry where a significant percentage of operating employees are over forty years old. Other research suggests that deficits from sleep loss vary significantly across individuals and may actually be “trait-like” differences - not simply the result of sleep-wake history.¹⁶⁴ Individual differences in vulnerability to sleep disorders such as sleep apnea and insomnia may also influence alertness and fatigue in the workplace.¹⁶⁵ Thus, this may be an area for further study to examine the impact on railroad operations.

A comparison of the effects of sleep loss and ingesting ethanol illustrates the impact that sleep deprivation has on performance.¹⁶⁶ As sleep deprivation and ethanol increased, so did daily sleep latency - both as a linear function of dose, with sleep loss in hours being 2.7 times more potent than ethanol in grams per kilogram.¹⁶⁷ Ethanol and sleep loss, both equipotent in their impairing effect, also slowed reaction time on the psychomotor vigilance test.¹⁶⁸

In sum, well-documented evidence suggests that sleep loss is significantly related to reductions in cognitive performance. Interestingly, Pilcher and Huffcutt noted that “[a]lthough most of the sleep research community may concur with these results, there are a surprising number

160. *Id.* at 133.

161. *Id.* at 131.

162. A. Buguet et al., *Modafinil: Medical Considerations for Use in Sustained Operations*, 74 AVIATION, SPACE, & ENVTL. MED. 659 (2003).

163. K. Reid & D. Dawson, *Comparing Performance on a Simulated 12 Hour Shift Rotation in Young and Older Subjects*, 58 OCCUPATIONAL AND ENVTL. MED. 58, 61 (2001).

164. H.P.A. Van Dongen et al., *The Cumulative Cost of Additional Wakefulness: Dose-Response Effects on Neurobehavioral Functions and Sleep Physiology from Chronic Sleep Restriction and Total Sleep Deprivation* 26 SLEEP: J. OF SLEEP & SLEEP DISORDERS RES. 117, 124 (2004).

165. *Id.* at 125.

166. T. Roehrs et al., *Ethanol and Sleep Loss: A “Dose” Comparison of Impairing Effects*, 26 SLEEP: J. OF SLEEP & SLEEP DISORDERS RES. 981, 981 (2003).

167. *Id.* at 983.

168. *Id.* at 983-84.

of scientists outside the sleep research field who have concluded that sleep deprivation has no profound effect on performance.”¹⁶⁹ It appears that this same situation exists in the railroad industry where most industry players understand that sleep deprivation is a fact of life yet few recognize or admit to the reduction in performance that follows short, long, or even partial sleep deprivation.

C. SLEEP RESTRICTION OR PARTIAL SLEEP DEPRIVATION

Pilcher and Huffcutt’s review of partial sleep deprivation findings have direct implications for the railroad industry.¹⁷⁰ Given that railroad work involves variable start times and shift lengths, the working conditions in the railroad industry closely approximate the definition of partial sleep deprivation.¹⁷¹ Partial sleep deprivation, in other words, occurs when individuals are required to sleep less than five hours in a twenty-four hour period.¹⁷² Pilcher and Huffcutt’s results suggest that cognitive performance is more affected by partial sleep deprivation incurred over days than either short (less than or equal to forty-five hours) or long (greater than forty-five hours) duration total sleep deprivation.¹⁷³ Given the erratic nature of railroad work schedules, it is therefore likely that railroad sleep schedules are more similar to partial sleep restrictions than to acute total sleep deprivation. Research by Sherry emphasizes this conclusion. In a study of railroad employees, Sherry found that the average amount of sleep for the entire group of thirty-three individuals per twenty-four hour period was 6.32 ± 1.68 , ranging from a low of 2.75 average hours of sleep per twenty-four hour period to a high of 10.02 hours of sleep.¹⁷⁴ Sherry estimated that as many as 45.5% of the sample population averaged fewer than 5.93 hours of sleep during the assessment period.¹⁷⁵

According to the National Sleep Foundation’s “2000 Omnibus Sleep in America Poll,” shift workers, on average, get less sleep during the week (six hours and thirty minutes) compared to regular day workers (six hours and fifty-four minutes), and almost half of the shift workers average less than 6.5 hours of sleep while far fewer regular day workers aver-

169. Pilcher & Huffcutt, *supra* note 153, at 323.

170. J.J. Pilcher & M.K. Coplen, *Work/Rest Cycles in Railroad Operations: Effects of Shorter Than 24-h Shift Work Schedules and On-Call Schedules of Sleep*, 43 *ERGONOMICS* 573, 573-576 (2000).

171. *Id.* at 575.

172. Pilcher & Huffcutt, *supra* note 153, at 319.

173. *Id.* at 319.

174. PATRICK SHERRY, FINAL REPORT ON ASSESSMENT OF FATIGUE IN TRAIN AND ENGINE EMPLOYEES OF THE UNION PACIFIC RAILROAD IN THE SAN ANTONIO AREA 21 (Intermodal Transp. Inst. ed., Ass’n Am. R.R. 2005).

175. *Id.*

age this amount of sleep during the workweek.¹⁷⁶ Given the mean, we can assume that a substantial portion of these shift workers obtain fewer than five hours of sleep per night - consistent with the research conducted by Pilcher and Huffcutt.¹⁷⁷

In a similar vein, the Mitler study of eighty truck drivers carrying revenue-producing loads on four different driving schedules (either nighttime or daytime driving) revealed that the average time spent in bed was just over 5.18 hours.¹⁷⁸ The longest times in bed were for drivers on the day schedules while nighttime drivers spent the least number of hours in bed.¹⁷⁹ Younger drivers with an average age of thirty-six spent more time in bed (including more naps) than older drivers, whose average age was fifty.¹⁸⁰ The drivers in this study averaged 5.18 hours in bed per day over the five-day study (with a range of 3.83 hours for the thirteen-hour night schedule to 5.38 hours for the ten-hour day schedule).¹⁸¹ Forty-four percent of the drivers took naps to increase their sleep.¹⁸² Thus, work schedules significantly influenced the length of time the drivers slept.

Recent studies indicate that performance errors in air traffic controllers increased by 15%-18% over a five-day midnight workweek schedule.¹⁸³ In addition to perceived performance decrements, the research demonstrated performance changes across various shifts.¹⁸⁴ The authors found that sleeping in the "morning (daytime) and in the evening resulted in significantly greater losses of sleep than sleeping during the night, with evening sleeps being 1.5 times shorter than day sleeps (3.5 hours vs. 2.2 hours, respectively, of lost sleep for a single sleep period - group means)."¹⁸⁵ In other words, it appears "controllers in the study got much less sleep during daytime and evening sleeps."¹⁸⁶ These partial sleep deprivations significantly affected work performance.¹⁸⁷ For example, air traffic controller performance concerning reaction times, logical reasoning, and spatial relations began to deteriorate 5-10% on the second mid-

176. Public Broadcasting Serv., *Sleep and Safety Factoids*, http://www.pbs.org/livelihood/nightshift/sleep_and_safety.html (last visited Oct. 5, 2006).

177. Pilcher & Huffcutt, *supra* note 153, at 319.

178. Merrill M. Mitler et al., *The Sleep of Long Haul Truck Drivers*, 337 NEW ENG. J. OF MED. 755, 4 (1997).

179. *Id.*

180. *Id.* at 4-5.

181. *Id.*

182. *Id.* at 5.

183. Wayne Rhodes et al., *Impact of Shiftwork on Air Traffic Controller, Phase II: Analysis of Shift Schedule Effects on Sleep, Performance, Physiology and Social Activities*, TP 12816E TRANSP. DEV CENTRE REP. OF TRANSPORT CANADA 35 (1996).

184. *Id.* at 36-39.

185. *Id.* at viii.

186. *Id.*

187. *Id.* at 36.

night shift - by the fourth midnight shift, performance was 10-18% less than the baseline percentage.¹⁸⁸ For the evening-day-day-midnight-midnight (EDDMM) shift, significant performance deterioration did not occur until the midnight shifts, with a 6-12% reduction in reasoning, spatial orientation, and pattern recognition.¹⁸⁹ For the EEDDMM shift, performance impairment of 5-15% was evident beginning during the second day and midnight shifts.¹⁹⁰ This difference in performance impairments may be due to the length of the workday which interferes with the person's ability to obtain rest in the time available.¹⁹¹

One study found that truck drivers suffering from restricted sleep had an increased reaction time of 650 milliseconds over baseline values.¹⁹² According to the authors of the study, this longer reaction time translates into an increase of twenty-three meters in breaking distance at a speed of seventy-five miles per hour.¹⁹³

Several sleep dose response studies present strong evidence on the impact of restricted sleep over time. In the first study, sixteen healthy young adults who had their sleep restricted to an average 4.98 hours per night for seven consecutive nights reported higher levels of subjective sleepiness and had significantly longer reaction times on performance tasks.¹⁹⁴ A second study showed dose-dependent performance impairment related to sleep loss in participants who slept for three, five, seven, and nine hours respectively.¹⁹⁵ Performance in the three-hour sleep group typically declined below baseline within two to three days of sleep restriction.¹⁹⁶ Performance in the five hour sleep group was consistently lower than performance in the seven and nine hour sleep groups.¹⁹⁷ In contrast, performance in the seven and nine hour sleep groups was often indistinguishable and improved throughout the study.¹⁹⁸ Virtually no negative effects on performance were seen in the nine hour sleep group.¹⁹⁹

188. *Id.* at 38.

189. *Id.* at 36.

190. *Id.* at 86.

191. *Id.* at 78-82.

192. P. Philip et al., *Fatigue, Sleep Restriction, and Performance in Automobile Drivers: A Controlled Study in a Natural Environment*, 26 SLEEP: J. OF SLEEP AND SLEEP DISORDERS RES. 277, 278, 279 (2003).

193. *Id.* at 279.

194. D. Dinges et al., *Cumulative Sleepiness, Mood Disturbance and Psychomotor Vigilance Performance Decrement During a Week of Sleep Restriction to 4-5 Hours Per Night*, 20 SLEEP 267, 267-70 (1997).

195. T. BALKIN, ET AL., EFFECT OF SLEEP SCHEDULES ON COMMERCIAL MOTOR VEHICLE DRIVER PERFORMANCE (2000).

196. *Id.* at 2-84.

197. *Id.*

198. *Id.*

199. *Id.*

The second study is interesting from the railroad perspective in that it points to the importance of arranging work schedules so that individuals can obtain at least seven hours of sleep. Even though railroad workers are permitted a minimum of eight undisturbed hours, workers generally spend less than six hours asleep due to commute and preparation times. The study emphasizes that this type of situation does not foster maximum performance levels.²⁰⁰

The study further found that following chronic sleep restriction, the first eight hours in bed (6.5 hours of sleep) are insufficient for restoration of performance on the psychomotor vigilance task (PVT).²⁰¹ During the four day recovery phase (eight hours in bed each night), five and seven hour sleep groups showed minimal or no recovery, remaining consistently below the nine hour sleep group and below their own baseline levels for the PVT.²⁰² The three hour sleep group showed some recovery for the PVT on the first day and more on subsequent days but also remained well below their own baseline and below the performance of the other groups.²⁰³ Subjects' recovery to baseline or near baseline levels of performance on the PVT often required a second or third night of recovery sleep.²⁰⁴ These data suggest that after sleep debt has occurred (three, five, seven hours time in bed) a single bout of eight hours of night sleep leads to recovery but not full recovery.²⁰⁵ While further sleep is required for full recovery, the number of subsequent sleep periods to reach full recovery is unknown.²⁰⁶ For the three-hour group, the data suggests that even three nights of normal sleep (eight hours spent in bed on each night) is not sufficient to restore performance to baseline levels (depending on the task).²⁰⁷ Balkin concludes that "this suggests that full recovery from severe, extended sleep restriction may require more than three nights of normal-duration sleep."²⁰⁸

Belenky et al. examined a subset of the Balkin data, specifically looking at the PVT information.²⁰⁹ For participants in the three-hour test group, performance on reaction time measures declined steadily over the seven-day period.²¹⁰ Performance by participants in the five and seven-

200. *Id.* at 4-50.

201. *Id.* at 2-85.

202. *Id.* at 2-86.

203. *Id.*

204. *Id.* at 2-85.

205. *Id.*

206. *Id.*

207. *Id.*

208. *Id.*

209. G. Belenky et al., *Patterns of Performance Degradation and Restoration During Sleep Restriction and Subsequent Recovery: A Sleep Dose-Response Study*, 12 J. SLEEP RES. 1, 2 (2003).

210. *Id.* at 1.

hour groups initially declined but stabilized subsequently.²¹¹ For participants in the nine-hour group, performance remained at the baseline level.²¹² During the recovery period the performance levels did not return to baseline levels after three days of recovery.²¹³ Reaction times and lapses for the three hour group showed an initial recovery, but only to the levels of the five and seven hour condition, not the baseline.²¹⁴

Interestingly, the data also shows that sleep restriction on the first two nights in the experimental period of only five hours, resulted in performance decrements that were no more than 5% off baseline.²¹⁵ In addition, sleep restriction of two consecutive nights with less than four hours per night in the experimental condition resulted in performance decrements of no more than 13%.²¹⁶ Only after the third consecutive night, with less than three hours of sleep, did performance drop 20% below baseline.²¹⁷ Thus, these results suggest that persons can endure two consecutive nights with less than six hours of sleep without incurring a performance degradation of more than 5%.²¹⁸ However, three consecutive nights of less than six hours of sleep does result in performance degradation of 15% or more.²¹⁹

Collectively, the data suggest that the HOS sleep guidelines might need to ensure that persons in operational settings obtain at least six hours of sleep in a twenty-four hour period and twelve hours in a forty-eight hour period.²²⁰ Put another way, performance is not noticeably affected when individuals obtain less than six hours of sleep over two consecutive twenty-four periods.²²¹ However, performance decrements are noticed with more than two consecutive twenty-four hour periods with less than six hours of sleep per night.²²²

Van Dongen, Maislin, Mullington, and Dinges studied the effects of chronic sleep restriction by examining the effects of four, six, or eight-hour sleep schedules on forty-eight healthy adults over a fourteen-day period.²²³ Results indicate that restriction of sleep of six hours or less per night produced cognitive performance deficits equivalent to two nights of

211. *Id.*

212. *Id.*

213. *Id.*

214. *Id.*

215. *See id.* at 6-7.

216. *Id.*

217. *Id.*

218. *See id.* at 1, 9.

219. *See id.* at 6-7.

220. *Id.*

221. *See id.* at 5-6.

222. *See id.* at 6-7.

223. Van Dongen et al., *supra* note 164, at 117.

total sleep deprivation.²²⁴ “Cumulative wakefulness in excess of 15.84 hours predicted performance lapses across all four experimental conditions.²²⁵ Thus, it appears that even relatively moderate amounts of restricted sleep can seriously impair cognitive function.

Participants were largely unaware of these increasing cognitive deficits.²²⁶ Mild restriction in the hours of sleep (five hours a night rather than 7½) have been shown to result in progressive daytime sleepiness which is evident on the first day following a night of sleep restriction and worsens with successive restrictive nights.²²⁷ The resulting sleepiness is only recoverable by rest. One night of rest following one week of sleep restriction only partially reverses the problem.²²⁸ Artificial fragmentation of sleep also rapidly results in an increasing tendency to fall asleep. Sleepiness is also influenced by time of day, increasing significantly in the early hours of the morning.²²⁹

Williamson, Feyer, Friswell and Finlay-Brown, looked at the effectiveness of two consecutive sixteen hour work periods separated by six hour breaks.²³⁰ The study took place in a simulation mode as the hours of work were not legal, but the study involved the professional long distance truck drivers who would have done the trip.²³¹ The results prove again that in rested drivers there were no significant fatigue effects after sixteen hours of work, but after only a six-hour continuous rest break, significant fatigue effects occurred around the middle of the second sixteen hour shift.²³² This indicates that longer hours of work may be possible, provided that the days are balanced by an appropriate period of longer rest.

Partial sleep deprivation characterizes much of railroad operations. The fact that the railroad industry is characterized by rules which permit an employee to be awakened after only six hours of sleep is similar to the definition of partial sleep deprivation that Pilcher and Huffcutt used in their meta-analysis.²³³ Their findings indicated that the negative effects of partial sleep deprivation were about 40% greater than either short or

224. *Id.* at 117.

225. *Id.*

226. *Id.*

227. *Id.*

228. See Belenky et al., *supra* note 209, at 10.

229. *Id.* at 9.

230. See Ann Williamson et al., Dep't of Transp. and Reg'l Serv. Australian Transp. Safety Bureau, *Evaluating a Regulated Hours Regime On-Road and Alternative Compliance Regime Under Simulated Conditions*, CR 190 at 1, 71 (July 2000), available at http://www.atSB.gov.au/publications/2000/Duty_Time_2.aspx. (last visited Sept. 10, 2006).

231. See *id.* at 39.

232. See *id.* at 71.

233. Pilcher & Huffcutt, *supra* note 153, at 319.

long duration total sleep deprivation.²³⁴ Consequently, conditions which promote partial sleep deprivation contribute to reduced cognitive performance.²³⁵

Taken together, these studies provide consistent and strong evidence documenting the negative impact of restricted sleep on performance over time. The railroad industry in particular, with the two-hour call procedure, demands attention to the lower levels of restricted sleep. Specifically, detailing a limit to minimum time needed to recover. These studies suggest that the effects of even partial sleep restriction can lead to noticeable reductions in performance. The Belenky data suggest that performance decrements are noticed with more than two consecutive twenty-four hour periods with less than six hours of sleep per night.²³⁶ Accordingly, it should be apparent that there will be a need to minimize the occurrence of more than two consecutive days of partial sleep reduction situations in the railroad working environment.

D. RECOVERY PERIODS

Issues of recovery for shift work have been discussed by various parties. A paper by Totterdell, indicates that there were significant decrements in performance over the course of several night shifts.²³⁷ Furthermore, several measures did not improve on the first rest day after a night shift.²³⁸ Thus, there may be a need for considerable time off before a return to optimal performance is obtained.

Smiley and Heslegrave completed a review of the literature with respect to recovery time needed for CMV drivers.²³⁹ The first study reviewed indicated that a single day off was "insufficient for night workers to recover after an accumulated sleep debt from 5 days of work."²⁴⁰ Smiley and Heslegrave concluded that "two nights of recovery sleep is usually sufficient to allow full recovery."²⁴¹ This conclusion is still widely regarded as correct. However, the degree to which it may be true for partial sleep loss over extended periods is unknown.²⁴²

The O'Neill study includes ten CMV drivers in a simulator with fifty-

234. *See id.* at 324.

235. *Id.* at 325.

236. *See* Belenky et al., *supra* note 209, at 5-8.

237. Peter Totterdell et al., *Recovery From Work Shifts: How Long Does It Take?*, 80 J. OF APPLIED PSYCHOLOGY 43, 43 (1995).

238. *Id.* at 54.

239. Alison Smiley & Ron Heslegrave, *A 36-Hour Recovery Period for Truck Drivers: Synopsis of Current Scientific Knowledge*, TP 13035E TRANSPORTATION DEVELOPMENT CENTRE SAFETY AND SECURITY GROUP OF TRANSPORT CANADA, 3 (1997).

240. *Id.* at 15.

241. Smiley & Heslegrave, *supra* note 239, at 8.

242. *Id.*

eight hours of recovery time.²⁴³ The results of this study indicate that drivers returned to baseline on both subjective and performance measures after one night of recovery sleep.²⁴⁴

The Balkin study of CMV drivers determined that at least three recovery days were needed to return to near baseline.²⁴⁵ The subjects' recovery to baseline required two or three nights of recovery sleep.²⁴⁶ Balkin concluded that:

. . . when performance did recover, it was generally not complete after the first 8-h recovery sleep period. Rather, recovery to baseline or near baseline levels of performance often required a second or third night of recovery sleep. This observation clearly indicates that following chronic sleep restriction, eight hours in bed (which resulted in approximately 6.5 hours of sleep) is insufficient for restoration of performance on tasks requiring higher-order cognitive processing.²⁴⁷

Akerstedt's study determined that most shift workers reported that they needed at least two days with two normal sleep episodes to recover after three consecutive night shifts.²⁴⁸ This study also demonstrated that the need for recovery increased by one day when working a succession of seven consecutive shifts.²⁴⁹ Evidence from jet lag indicates that it may take up to four days to recover after an acute shift of the sleep wake pattern.²⁵⁰ Smiley & Heslegrave noted that there was no difference between the first and seventh shift in terms of sleepiness for 83 construction workers, working an 84 hour week (i.e., seven consecutive 12 hour day shifts between 07:00 to 19:00 followed by a week off).²⁵¹ However they required three to four days of recovery to reach normal sleepiness values.²⁵² Thus, a review of several non-driving studies concluded that rest periods between work shifts were sufficient to improve subjective alertness.²⁵³

Data on recovery are also available from the Belenky study of the partial sleep restriction of sixty-six normal volunteers who spent three, five, seven, or nine hours in bed (TIB) for seven days followed by three

243. FED. HIGHWAY ADMIN., *supra* note 115, at 2.

244. *Id.* at 3.

245. BALKIN ET AL., *supra* note 195, at 2-85.

246. *Id.*

247. *Id.*

248. AKERSTEDT, *supra* note 130.

249. *Id.*

250. Smiley & Heslegrave, *supra* note 239, at 7

251. A. SMILEY ET AL., INVESTIGATION OF COMMERCIAL MOTOR VEHICLE DRIVER CUMULATIVE FATIGUE RECOVERY PERIODS: LITERATURE REVIEW, TP 14206E TRANSPORTATION DEVELOPMENT CENTRE OF TRANSPORT CANADA 7, (2003).

252. *Id.*

253. *Id.* at 8.

days with eight hours TIB (recovery).²⁵⁴ For persons in either a three hour condition performance on reaction time measures declined steadily over the seven day period.²⁵⁵ For persons in the five and seven hour conditions, performance initially declined followed by stabilization.²⁵⁶ In the nine-hour group, performance remained at the baseline levels.²⁵⁷ During the recovery period the performance levels did not return to baseline levels *even after three days of recovery*. Reaction times and lapses of the three-hour group showed an initial recovery but only to the levels of the five and seven hour condition, not baseline. Thus, recovery for all participants on a restricted schedule was short of baseline levels.

The Van Dongen study of a group of forty-eight healthy individuals randomly assigned to either four, six, or eight hours in bed per night for a period of fourteen days also provides some information on recovery time.²⁵⁸ Total sleep deprivation involved three nights without sleep.²⁵⁹ Results indicated that sleep restriction of six hours or less per night produced cognitive performance deficits equivalent to up to two nights of total sleep deprivation.²⁶⁰ Interestingly, subjective ratings of sleepiness indicated that participants were “largely unaware” of the resulting declining cognitive performance.²⁶¹ In terms of recovery then it will be important to ensure that sufficient time for recovery actually exists.

To date we have only three studies that indicate how much time is actually needed to recover. Most sleep experts argue that at least a forty-eight hour period in which two eight-hour episodes of sleep are obtained is needed. However, the Belenky study suggests that even after three days individuals have not returned to baseline levels.²⁶² Further study of this phenomenon is clearly warranted. However, at present a definite period of time off of one to three days following partial sleep deprivation is needed to ensure near baseline recovery.

E. FATIGUE COUNTERMEASURES PLANS

Some efforts have been made in the workplace to address fatigue. Various summaries of Fatigue Countermeasures in the industry have been identified.²⁶³ While these reports are successful at documenting the various types of interventions that have been directed at reducing fatigue in

254. Belenky et al., *supra* note 209, at 1.

255. *Id.*

256. *Id.*

257. *Id.*

258. Van Dongen et al., *supra* note 164, at 117-126.

259. *Id.* at 117.

260. *Id.*

261. *Id.*

262. Belenky et al., *supra* note 209, at 10.

263. *See generally*, Sherry, *supra* note 87, at 30-31.

the workplace, they lack the comprehensiveness that their titles imply. Prescriptive recommendations on when and how many of these measures to apply, and in what circumstances or amounts, is difficult to quantify without knowledge of the specific conditions. Accordingly, many experts in the field are recommending a more holistic approach to fatigue management.²⁶⁴

During the testimony delivered in response to the FMCSA's Notice of Proposed Rulemaking for revising HOS regulations, a number of witnesses expressed "interest in developing a more holistic approach to the fatigue problem through the use of education and training programs, and screening for sleep apnea and other sleep disorders . . . usually mentioned in the context of fatigue management."²⁶⁵ The National Sleep Foundation (NSF) pushes for widespread instruction about the necessity of sleep and alertness, as well as the prevention of drowsy driving, for commercial drivers.²⁶⁶ The NSF further promotes a standard of "no-fault" screenings among commercial drivers for sleep disorders.²⁶⁷ The NSF fears that without standardizing and enforcing the number of hours of service per day for commercial drivers, the drivers and the public will continue to be at risk for accidents while traveling on roads.²⁶⁸

In his 1999 testimony before Congress, Michael Mann, the Deputy Associate Administrator of NASA commented that, "[i]t should be evident that no single approach or 'fix' can eliminate fatigue as an issue from aviation and other around-the-clock operations."²⁶⁹ He further noted that any approaches to eliminate such fatigue need to allow for flexibility by the operators.²⁷⁰ However, it does not appear that this advisory circular has been adopted.

In the 1990's, in order to address fatigue issues, Canadian National combined with Canadian Pacific and VIA Rail to form a task force in conjunction with The Brotherhood of Locomotive Engineers, with Circadian Technologies providing assistance.²⁷¹ A pilot project resulting from the collaboration was initiated in 1995 in Calgary and Jasper, titled

264. See FMCSA, Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations, 68 Fed. Reg. 22,456, 22,460 (Apr. 28, 2003) (codified at 49 C.F.R. §§ 385, 390, 395).

265. *Id.*

266. Press Release, National Sleep Foundation, Statement Regarding New Hours of Service Rules for Truckers (Apr. 30, 2003), <http://www.sleepfoundation.org/press/index.php?secid=&id=132>.

267. *Id.*

268. *Id.*

269. *Pilot Fatigue: Hearing Before the House Aviation Subcomm. of the House Comm. on Transportation and Infrastructure*, 106th Cong. (1999) (statement of Michael B. Mann, Office of Aero-Space Technology, National Aeronautics and Space Administration), <http://human-factors.arc.nasa.gov/zteam/fcp/congressional-hearing.html>.

270. *Id.*

271. Sherry, *supra* note 87, at 34.

CANALERT.²⁷² The CANALERT project set up three time pools or specific blocks of time for locomotive engineers to designate when they would begin their next assignment.²⁷³ Engineers starting their assignments between 5:00 and 15:00 were called Larks, while those starting between 13:00 and 23:00 were called Owls, and those between 21:00 and 07:00 were called Cats.²⁷⁴ The calling windows were only in effect for assignments beginning at the home terminal, with returns to home governed by the traditional first-in/first-out policy.²⁷⁵ A protected zone was established for the times when an engineer would be most likely to experience fatigue.²⁷⁶ Engineers were permitted to take a return train home without rest only if he could be guaranteed to arrive before the beginning of his protected zone; otherwise, the engineer was required to rest for at least three hours at the away from home terminal.²⁷⁷ Finally, a “special protected zone” was also created to ensure the availability of protection for engineers traveling during a time when fatigue might be a problem.²⁷⁸ Engineers in the special protected zone were permitted to take a nap if needed.²⁷⁹

Engineers in the CANALERT project were also assigned a regular work schedule, with each engineer working one day and off the next.²⁸⁰ Furthermore, each engineer received two assigned days off in each twenty-eight-day schedule.²⁸¹ Assigned days off were built into the regular work schedule, resulting in at least three consecutive days off, and engineers were also allowed to book up to eight hours rest at the away from home terminal.²⁸² Significant improvements on subjective measures of fatigue and alertness were obtained, with operational measures also indicating improvements.²⁸³

In the Canadian aviation industry the Tripartite Working Group (TWG) (made up of representatives from Transport Canada, Canadian Air Traffic Control Association and NAV Canada) was formed to address fatigue issues facing Canadian air traffic controllers.²⁸⁴ As a result of

272. *Id.*

273. *Id.*

274. *Id.*

275. *Id.*

276. *Id.* at 34-35.

277. *Id.* at 35.

278. *Id.*

279. *Id.*

280. *Id.*

281. *Id.*

282. *Id.*

283. *Id.* at 37.

284. DOUG MEIN, TRANSPORT CANADA REPORT TO THE TRIPARTITE STEERING COMMITTEE ON ATC FATIGUE, TP 13742E i (2001), available at <http://www.tc.gc.ca/CivilAviation/ANSandA/fatigue/Atc.pdf>.

their work the TWG issued a report which made several recommendations regarding how to address fatigue in this very critical safety operation.²⁸⁵ The committee report included the following four recommendations:

- Adopt a holistic approach to fatigue management by all parties to the Tripartite Working Group and Tripartite Steering Committee;²⁸⁶
- Have NAV CANADA introduce a formal Fatigue Management Program;²⁸⁷
- Integrate NAV CANADA's Fatigue Management Program into the Corporation's Safety Management System in a manner fatigue-related safety risks are managed practically and efficiently;²⁸⁸ and
- Develop a performance-based measurement system to gauge the effectiveness NAV CANADA's Fatigue Management Program.²⁸⁹

It is interesting to note that the TWG report included a discussion of the issues of *prescriptive* vs. *non-prescriptive* approaches to the management of fatigue.²⁹⁰ Currently, many regulatory bodies utilize a *prescriptive* approach that identifies certain limits under which operations may occur.²⁹¹ On the other hand, the *non-prescriptive* approach recognizes the need for flexibility in operations as a crucial component to maintaining service.²⁹² The committee concluded that a *non-prescriptive* approach, focusing on the desired outcomes and behaviors, was the most acceptable.²⁹³

Transport Canada also completed an extensive review of fatigue counter measures in the transportation industry.²⁹⁴ This document lists a number of suggestions for addressing fatigue including:

- Implement education programs addressing shift work, scheduling work and rest, and proper regimens of health, diet, and rest;²⁹⁵
- Employ fatigue management programs across all transportation industries;²⁹⁶
- Encourage performance-based safety approaches and self-management

285. *Id.*

286. *Id.*

287. *Id.* at ii.

288. *Id.*

289. *Id.*

290. *Id.* at 7.

291. *Id.*

292. *Id.*

293. *Id.*

294. See DIANE D. BOIVIN, TRANSPORT CANADA, BEST PRACTICES COMPENDIUM OF FATIGUE COUNTERMEASURES IN TRANSPORT OPERATIONS TP 13620E (2000), available at <http://www.transport-canada.org/tdc/publication/pdf/13600/13620e.pdf>.

295. *Id.* at xiii.

296. *Id.*

- with feedback through measurement technologies;²⁹⁷
- Limit 12-hour shifts;²⁹⁸
 - Improve the regularity of duty periods on reserve and on-call assignment and reduce the element of unpredictability;²⁹⁹
 - Promote a healthy night's rest before a trip;³⁰⁰
 - Encourage napping on trips, specifically during night shifts or on cruise portions of long-haul flight operations;³⁰¹
 - Limit night shifts to two to three consecutive shifts;³⁰²
 - Avoid 12-hour night shifts;³⁰³
 - Provide at least two full days of rest after extended duty periods, particularly if night work was involved;³⁰⁴
 - Provide at least nine hours of rest between consecutive shifts;³⁰⁵
 - Limit overtime to a minimum;³⁰⁶ and
 - Provide adequate areas for strategic napping.³⁰⁷

This list is very similar to that proposed by the Work Rest Task Force addressing the needs for fatigue management in the railroad industry.³⁰⁸ The Work Rest Task Force, in an effort to improve fatigue management, identified eight key components of an effective fatigue counter measures program.³⁰⁹ A committee comprised of senior railroad executives endorsed the list on February 23, 1998, and railroads are still attempting to integrate the principles into their individual programs.³¹⁰

An effective Fatigue Countermeasures Program (FCP) should consider, but is not limited to, the following:

- Education and Training
- Employee and Train Scheduling Practices (e.g., line-ups, calling times, work/rest cycles, relief-staffing, employee availability, shift predictability)
- Emergency response requirements (short-term, e.g., derailments, and extended, e.g., natural disasters)
- Alertness strategies (e.g., napping, employee empowerment)
- Evaluation of policies and procedures (e.g., effects on fatigue issues)
- Rest environments (e.g., lodging)
- Work environments

297. *Id.*

298. *Id.*

299. *Id.*

300. *Id.*

301. *Id.*

302. *Id.*

303. *Id.*

304. *Id.*

305. *Id.*

306. *Id.*

307. *Id.*

308. See Sherry, *supra* note 87, at 33.

309. *Id.*

310. *Id.*

- Implementation strategies and review of FCP effectiveness.³¹¹

Unfortunately, these recommendations have been implemented with only limited success. In an effort to improve on the consistency of the rules' implementation and in conjunction with revising the hours of service rules, Transport Canada along with the Canadian Railways and Labor organizations issued Work/Rest Rules developed pursuant to Canada's Railway Safety Act.³¹² The Canadian Work/Rest Rules include the requirements regarding fatigue management plans:

- Railways must implement such plans;³¹³
- Such plans must be designed to decrease fatigue and improve on-duty awareness of operating employees;³¹⁴ and
- Such plans must reflect the nature of the operations under consideration.³¹⁵

The FCPs address employee work scheduling practices, employee education and training, on-job alertness strategies, rest and work environments, how to handle working under unusual operating conditions, and unique deadheading circumstances.³¹⁶ Specific plans should be put in place in special circumstances where the operating practices necessitate exceeding specific guidelines.³¹⁷

The concept of the FCPs addresses the need for a holistic approach to fatigue management.³¹⁸ The complexity of the variables that affect fatigue and alertness are of such magnitude that is difficult to identify specific practices that would be required in all circumstances. The problem in simple terms is "one size does not fit all." Transport Canada adopted the *non-prescriptive* approach discussed earlier.³¹⁹

Various groups and reports have attempted to address the need for changes in transit operators' hours of service. Interestingly the experts, laborers, and managers appear to value both a prescriptive and a non-prescriptive approach. A non-prescriptive approach to the management of fatigue is highly desirable due to the many complex variables that interact to increase or decrease alertness. However, a prescriptive ap-

311. *Id.*

312. See generally Railway Safety Act, R.S.C., ch. 32, § 20 (1985) (Can.); See Transport Canada, Work/Rest Rules for Railway Operating Employees (June 2005), available at http://www.tc.gc.ca/railway/Rules/TC_O_0_50.htm.

313. Transport Canada, Work/Rest Rules for Railway Operating Employees, § 6.1.1 (June 2005), available at http://www.tc.gc.ca/railway/Rules/TC_O_0_50.htm.

314. *Id.* § 6.1.2.

315. *Id.* § 6.1.3.

316. *Id.* § 6.2.2.

317. See *id.* at § 6.2.4.

318. See MEIN, *supra* note 284, at 4.

319. See *id.* at 7.

proach is necessary for accountability. Consequently, some form combining both may hold the most promise for the United States rail industry.

III. SOME INITIAL RECOMMENDATIONS

A. FATIGUE COUNTERMEASURES PLANS

Railroad carrier companies should develop Comprehensive Fatigue Counter Measures Plans to address and manage fatigue issues in their operations:

The HOS regulations at present are *prescriptive*. Most authorities on the topic of regulations are concerned that a prescriptive approach is impractical, overly rigid and likely to create more problems than it solves.³²⁰ Consequently, due to the complex array of variables that influence a person's ability to function at an optimal level it is extremely unrealistic to develop a rule that will cover all the contingencies and still be practical.³²¹ The rationale for this approach is based on the idea that fatigue is a condition of the workplace that should be managed like any other hazard or risk to working safely.³²² Fatigue should not be considered as a category in and of itself, but rather integrated into the array of risks that are regularly managed by transportation professionals in the workplace.³²³

The idea that fatigue should be managed as part of the workplace environment has been informally discussed by a number of different individuals but not formally described. Various discussions held by the North American Rail Alertness Partnership (NARAP) address the need to develop a comprehensive plan to address fatigue in the workplace as it relates to safety and health of the work. Fatigue Management Plans (FMPs) are in use in Canada and several of the U.S. based carriers (e.g. UPRR, BNSF) have been required to file a plan with Transport Canada because some of their operations enter Canada.³²⁴ Given the importance of these issues and the concerns for public safety, it is recommended that the plans be filed with the Federal Railroad Administration. A panel of experts should be developed to review the plans and determine their adequacy. Finally, FMPs should serve as an agreement between labor, management, and the regulatory agencies that will enable the public and other stakeholders to assess the adequacy of those plans. Such FMPs should attempt

320. See MEIN, *supra* note 284, at 7.

321. See *id.* at 5.

322. See generally *id.* at 4-7.

323. See generally *id.*

324. See generally Transport Canada, Work/Rest Rules for Railway Operating Employees, at §§ 3.4, 6.1, 7.1.

to adhere to the recommendations outlined in this report and to general principles of constructing work schedules. Practical factors that have been identified as influencing the effectiveness of a work schedule include the following that were summarized in a report designed to improve the mitigation of fatigue:

1. The number of consecutive hours worked
2. The number of consecutive shifts
3. Start and end times
4. Level of cognitive activity required on task
5. Opportunities for rest, sleep and napping
6. Individual differences

B. HOURS ON DUTY

The maximum number of consecutive hours of on-duty time at work should not exceed twelve hours. Except in extraordinary circumstances, the maximum number of hours at work (on duty and pre-release) should also be limited to sixteen and include the amount of time preceding release with a minimum of twelve hours undisturbed rest immediately following:

The literature reviewed indicates that performance decrements have been observed in individuals working prolonged hours. Several studies have indicated that performance decrements may occur for persons working twelve-hour shifts.³²⁵ While in some situations it may be possible to work for more than twelve hours, it is not recommended. However, it is understandable that if an individual is in the midst of a shift and cannot be relieved from their place of operations immediately; such individual can end up being inactive but at work and not released for several hours.³²⁶ This situation can extend the workday a number of hours and should be counted when determining amount of time on duty and amount of needed recovery time. Basically, the amount of time that a person is awake should be considered whether the person is operating equipment or awaiting release, as the individual is unable to obtain rest.

C. CONSECUTIVE SHIFTS WORKED

Individuals should work no more than four consecutive twelve-hour shifts in a 144 hour period, and these consecutive work periods should be followed by at least a two day recovery time. Furthermore, consideration should be given to the practicality and likelihood of actually obtaining sleep, based on considerations of the circadian rhythms of the human body, during the time available:

325. Rosa et al., *supra* note 111, at 155.

326. S. REP. No. 108-182, at 6 (2003).

Evidence for this recommendation is based on the work of those who have found that performance deteriorated after four consecutive twelve-hour shifts.³²⁷ This recommendation is further based on the notion that the freight railroad environment is not necessarily characterized by regular start times or daylight hours of work.³²⁸ Working during midnight hours is likely to result in more impaired performance over time than working during daylight hours alone.³²⁹ Thus, the findings of reductions in performance after four consecutive twelve hour shifts occurring in the daylight hours should perhaps be considered optimal given the conditions in the freight railroad industry with variable start times.

In addition, the literature indicates that some shifts are more disruptive of circadian rhythms than others. The body has a natural tendency to sleep during the hours between midnight and 5:00 a.m.³³⁰ Consecutive midnight shifts have been shown to result in decreased performance.³³¹ Unfortunately, work shifts that start earlier in the morning conceivably result in less sleep because the worker will often not be able to compensate by going to bed earlier in the evening. Thus, if a worker with a 7:00 a.m. start time awakens at 5:00 a.m. (assuming a two-hour call) that worker will likely obtain only seven hours of sleep. The scenario probably changes considerably if work schedules occur during the midnight hours. For example, a person who works nights and gets off at 6:00 a.m. will conceivably get to bed at around 8:00 a.m. and have enough time to obtain a fairly adequate six hours of sleep. Thus, based on these considerations it is likely that a work schedule that has four or more consecutive twelve-hour shifts could result in performance degradations.

The other important consideration for this recommendation is the need to address whether the person will be working or sleeping at a time consistent with their circadian rhythm.³³² As was seen in the CANALERT study, the work schedules were arranged in accordance with the likelihood of fatigue or alertness, and a “special protected zone” was created to ensure that safeguards or counter measures were available for engineers traveling during a time when fatigue might be a problem.³³³ During this “special” zone an engineer was permitted to take naps as needed.³³⁴

The overriding principle that should guide decisions in this area is

327. See Rosa et al., *supra* note 111, at 155; See Rhodes et al., *supra* note 183, at viii.

328. See *Recent Derailments and Railroad Safety*, *supra* note 47, at 11.

329. Rhodes et al., *supra* note 183, at viii.

330. See generally *id.*

331. See *id.*

332. See Rhodes et al., *supra* note 183, at viii.

333. Sherry, *supra* note 87, at 35.

334. *Id.*

the need to address not just the number of hours worked, but the number of hours off between duty periods. Such rest hours will facilitate adequate rest for recovery. *In other words, we should take into account the number of hours a person will be able to sleep and the amount of sleep debt they will likely incur.* Opportunities to sleep need to increase so that operators get at least eight hours in each twenty-four hour period, and do not incur sleep debts over prolonged periods of time.

It is nearly impossible to come up with a rule that covers all possible scenarios that might occur. It is also true that railroad employees, like other individuals, regularly work safely with less than optimal work/rest cycles. However, to reduce risk, FMPs should be implemented that utilize the following principles to address fatigue problems:

- Individuals require approximately seven to eight hours of sleep in twenty-four hour periods to be at optimum levels of performance
- Individuals obtaining less than six hours of sleep for multiple days demonstrate reduction in performance
- When chances for sleeping an adequate amount decrease, there is greater need for mandatory time off
- When opportunities for sleep during the midnight hours are limited, individuals may need more time to recover from extended work periods

The goal is to eliminate sleep debt. Persons working mostly *during nighttime hours should be limited to no more than four work periods of twelve hours on duty, followed by at least twenty-four to forty-eight hours off* in order to recover from a sleep debt incurred.

D. RECOVERY TIME

1. On a daily basis, individuals should be afforded the opportunity to obtain eight hours of sleep per twenty-four hour period:

Research suggests that individuals who do not obtain at least five hours of sleep per night in a seven day period show a gradual decline in their cognitive performance by as much as 12% on the average.³³⁵ Individuals obtaining less than three hours of sleep per night are likely to experience an even more severe reduction in performance.³³⁶ Recovery times of three days did not return study participants to baseline levels of performance.³³⁷ Most likely there would be greater deficits if attempts to sleep occurred during times inconsistent with circadian rhythms.³³⁸ Consequently, individuals should obtain as close to eight hours of sleep as possible each day.³³⁹ In order to obtain eight hours of sleep it may be

335. See generally Belenky et al., *supra* note 209, at 6-8.

336. See *id.* at 1.

337. *Id.* at 10.

338. See Rhodes et al., *supra* note 183, at viii.

339. See Belenky et al., *supra* note 209, at 1.

necessary to give individuals at least ten hours off between shifts. Furthermore, if the work assignment ends between 3:00 a.m. and 6:00 a.m., twelve hours off may be needed for recovery.

2. A minimum of two days off is recommended to recover from extended work schedules:

Until recently experts have suggested that at least two nights of at least eight hours sleep are needed to recover from sleep deprivation. However, investigations of the dose-response relationship between sleep and performance suggest that even *three* recovery days may not be sufficient to recover from the *severe* sleep restriction.³⁴⁰ If an individual has worked more than four consecutive twelve-hour shifts with only ten hours off between shifts, the likelihood is great that the person has accumulated a sleep debt.³⁴¹ It is recommended that a person receive at least two days off to recover from their sleep debt. It may be necessary to mandate that the time-off be taken.

3. In order to recover from regular work shifts, there should be at least ten hours off between shifts in order to ensure eight hours of time in bed:

As discussed before, in order to fully recover and to function optimally it is necessary to have seven to eight hours sleep in every twenty-four hour period. Persons can function with less sleep but performance decreases as hours of wakefulness increases. While most evidence suggests that fragmented sleep results in performance decrements,³⁴² there is still no conclusion as to whether continuous as opposed to total amounts of sleep are needed to maximize recover. The current hours of service arrangements permit persons to have a two-hour call - effectively limiting sleep to six hours which, according to most studies, is a partial sleep restriction with subsequent reductions in performance.³⁴³ Rest periods should be sufficiently long to both provide recovery from long work hours and to prevent the buildup of accumulated sleep debt.

4. Persons who have worked several consecutive midnight shifts will require at least two days off and may need as much as twelve to sixteen hours off between shifts to recover:

Literature suggests that different shift patterns may result in greater performance decrements than others.³⁴⁴ In addition, consecutive midnight shifts are also found to have detrimental effects upon perform-

340. BALKIN ET AL., *supra* note 195, at 5-8.; Belenky et al., *supra* note 209, at 10.

341. See generally Rosa & Colligan, *supra* note 110, at 305.

342. Nancy J. Wesensten et al., *Does Sleep Fragmentation Impact Recuperation? A Review and Reanalysis*, 8 J. SLEEP RES. 237, 237 (1999).

343. See generally Pilcher & Coplens, *supra* note 170, at 574-75.

344. See Rhodes et al., *supra* note 183, at vii-viii.

ance.³⁴⁵ The ATC Group concluded that more than two consecutive midnight shifts have a detrimental cumulative impact on performance possibly due to the greater interference with circadian rhythms.³⁴⁶ The ATC Group indicated that fewer consecutive midnight shifts is better and that in the United Kingdom and New Zealand it is common practice to limit consecutive midnight shifts two or less.³⁴⁷

5. At the away-from-home terminal lodging facilities, railroad employees should be permitted shorter recovery times in order to return to their home expeditiously:

In cases where a worker has not worked a full twelve hours and desires to return to the home terminal, there may be conditions in which an extended duty period might be advantageous to allow the person to return to the home terminal for rest and recovery. Efforts are encouraged to determine a combination of hours together with a short rest break to allow this outcome. For example, in some cases it is possible to reach the away-from-home terminal in fewer than eight hours. The operator would still have at least four hours of work time available. Consequently, the operator could work a total of twelve hours and be within acceptable limits. If the person is well-rested upon beginning the first tour, has had a work assignment that is not predominantly in the midnight hours, can take a two hour nap before getting underway, and can reasonably be expected to return to the home terminal in under eight or nine hours, it may be possible to work a total of sixteen hours in a twenty-four hour period. The Canadian Work/Rest Rules attempt to address this by allowing employees to “reset” the clock after a six-hour break.³⁴⁸ However, this may not be advisable if the reset period occurs during a circadian period when the person is likely to be awake. In such a case it may be advisable to have the person continue working. These situations call for close monitoring - a well-defined FMP would also be desirable.

IV. CONCLUSION

Railroad carrier companies should develop Comprehensive Fatigue Counter Measures Plans to holistically address and manage fatigue issues in their operations. Furthermore, the maximum number of on-duty hours should remain at twelve hours in a twenty-four hour period. The maximum number of hours at work (on duty and pre-release) should be limited to sixteen, and should include the amount of time preceding release with a minimum of twelve hours undisturbed rest immediately following.

345. See MEIN, *supra* note 284, at 11.

346. *Id.*

347. *Id.* at 12.

348. See Transport Canada, Work/Rest Rules for Railway Operating Employees, at § 5.1.4.

It is further recommended that individuals be limited to a maximum number of four consecutive twelve-hour shifts in a 144-hour period. Consideration should be given to the practicality and likelihood of actually obtaining sleep, based on considerations of the circadian rhythms of the human body, during the time available. Individuals should be afforded the opportunity to obtain eight hours of sleep in every twenty-four hour period. A minimum of two days off is recommended to recover from extended work schedules. In order to recover from regular work shifts, there should be at least ten hours off between shifts in order to ensure eight hours of time in bed. Persons who have worked several consecutive midnight shifts will require at least two days off, and may need as many as twelve to sixteen hours off between shifts to recover. At the away-from-home lodging facilities, railroad employees should be permitted shorter recovery times in order to return to their homes.