FTA Report No. 0223

FTA RESEARCH
FEDERAL TRANSIT ADMINISTRATION

FTA Standards Development Program: Medical Fitness for Duty and Fatigue Risk Management

PREPARED BY
Center for Urban Transportation Research

U.S. Department of Transportation
Federal Transit Administration

JUNE
2022

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

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14. ABSTRACT

This research leveraged the findings and recommendations of US DOT research reports/guidance and research performed under the Transportation Research Board (TRB) Transit Cooperative Research Program (TCRP) on fatigue risk management, hours of service for transit workers, route and personnel scheduling, medical examination certificates, testing for sleep disorders, and training. CUTR's Transit Standards Working Group provided locally-based content to the background research, provided guidance and suggestions to the research team, and assisted in framing the final report and associated findings. CUTR identified gaps that may exist; current voluntary standards, recommended practices, or other forms of guidance that may need to be modified; or areas for which voluntary standards or other guidance should be developed.

15. SUBJECT TERMS
Fatigue risk management, medical examinations, medical fitness for duty, training, testing, sleep disorders, route scheduling, personnel scheduling, hazard analysis, biometric mathematical models

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Abstract

This research leveraged the findings and recommendations of US DOT research reports/guidance and research performed under the Transportation Research Board (TRB) Transit Cooperative Research Program (TCRP) on fatigue risk management, hours of service for transit workers, route and personnel scheduling, medical examination certificates, testing for sleep disorders, and training. CUTR's Transit Standards Working Group provided locally-based content to the background research, provided guidance and suggestions to the research team, and assisted in framing the final report and associated findings. CUTR identified gaps that may exist; current voluntary standards, recommended practices, or other forms of guidance that may need to be modified; or areas for which voluntary standards or other guidance should be developed.

Executive Summary

The Federal Transit Administration (FTA) directed the Center for Urban Transportation Research (CUTR) to perform research to address specific focus areas of transit safety risk in support of FTA's Standards Development Program. The research program leverages the findings and recommendations of FTA's Safety Standards research report, other US DOT research reports and guidance, and research performed under the Transportation Research Board (TRB) Transit Cooperative Research Program (TCRP). CUTR's Transit Standards Working Group lends locally-based content to the background research, provides guidance and suggestions to the research team, and assists in framing the final background research report and associated findings.

The research objectives for this report included the following:

- Perform background research and analysis on needs for new standards, recommended practices, guidance documents, or procedural considerations in the areas of medical fitness for duty and fatigue risk management.
- Identify gaps that may exist in standards, recommended practices, or guidance documents available to the industry to address medical fitness for duty and fatigue risk management.
- Present findings to FTA for its consideration related to the development or issuance of voluntary standards, protocols, guidelines, recommended practices, or additional research related to medical fitness for duty and fatigue risk management.

The Moving Ahead for Progress in the 21st Century Act (MAP-21) and its successor, the Fixing America's Surface Transportation (FAST) Act, prompted FTA to establish a Safety Management System (SMS) framework as the basis for its National Public Transportation Safety Program (49 United States Code [USC] Section 5329). SMS is a formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of the transit agency's safety risk mitigation. It includes systematic procedures, practices, and policies for managing risks and hazards."[1]

SMS Safety Risk Management (SRM) is a process used to assess a transit agency's risks and verify that systems are in place to control that risk. The process identifies hazards, assesses the hazards, identifies consequences of the hazards, and establishes the controls to manage risks. These hazards can be identified through a number of methods established as a part of a transit agency's SRM process. Although individual agencies have their own SRM methods to identify known and suspected hazards within their organizations,

[1] *Federal Register*, 83(139), July 19, 2018, p. 34428. 49 CFR Part 673, Public Transportation Agency Safety Plan Final Rule, § 673.5, Definitions.

other resources can be used to further inform their processes based on external event investigations.

In accident investigations performed by the National Transportation Safety Board (NTSB), fatigue, medical fitness for duty, and other related factors have been indicated as causal or contributing to fatal transportation events and are the source for recommendations to US Department of Transportation (US DOT) Modal Administrations dating back to 1989. NTSB's 2019–2020 Most Wanted List of Transportation Safety Improvements included these fatigue and medical fitness for duty-related topics.

Catastrophic events may be avoided if a transit operator, maintenance technician, dispatcher, or other transit employee responds timely and effectively to safety-critical tasks occurring during routine daily operations. A transit employee who is not medically fit for duty or is fatigued may be unable to effectively perform these safety-critical tasks and, therefore, may jeopardize their own safety or that of other transit personnel, riders, or the traveling public.

Research related to medical fitness for duty included an examination of medical examination certification/certificate regulations issued by US DOT Modal Administrations and regulations, laws, or directives prescribed by state DOTs, State Safety Oversight Agencies (SSOAs), or other state or regional authorities or those required locally. CUTR examined fatigue risk management including recognition of, reporting, and testing for sleep disorders, training programs that address these issues, and cognitive overload human factors. This research also included a review of Hours of Service (HOS) regulations and standards.

The research revealed many ways medical fitness for duty and consequently transit safety can be improved significantly by implementing best practices and policies. Robust employee safety reporting programs encourage employees to report fatigue and fitness for duty related concerns. Requiring pre-employment and return to duty medical examination certification for all safety-sensitive employees may reduce reportable incidents. Testing for sleep disorders and associated practices may reduce the potential risk factors associated with driving while fatigued. Hours of service policies that define the limits for driving time, time on duty, time off duty between shifts, maximum work week hours, maximum number of consecutive workdays, and emergency service provisions to reduce or mitigate fatigue risk may reduce the number of transit safety events. Additional findings and details supporting each finding are located in Section 5, the summary of findings.

Section 1

Introduction

The Federal Transit Administration (FTA) directed the Center for Urban Transportation Research (CUTR) to perform specific focus area research to address transit safety risks in support of FTA's Standards Development Program. These efforts are directed by FTA's Office of Research, Demonstration and Innovation in consultation with FTA's Office of Transit Safety and Oversight. Through the program, research and background studies are performed on focus area research topics to collect the information necessary to issue or support the update or development of voluntary transit standards, recommended practices, or other forms of industry guidance in cooperation and coordination with standard development organizations, such as the American Public Transportation Association (APTA).

To guide FTA's Standards Development Program, the research leveraged the findings and recommendations of FTA's prior research and study reports, other US DOT research reports and guidance, and research performed under the Transportation Research Board (TRB) Transit Cooperative Research Program (TCRP). CUTR's Transit Standards Working Group provided locally-based content to the background research, provided guidance and suggestions to the research team, and assisted in framing the final report and associated findings. Based on the research, CUTR identified gaps that may exist; current voluntary standards, recommended practices, or other forms of guidance that may need to be modified; or areas for which voluntary standards or other guidance should be developed.

Project Objectives

Objectives of this project were the following:

- Perform background research and analysis on needs and gaps for new standards, recommended practices, guidance documents, or procedural considerations in the areas of medical fitness for duty and fatigue risk management, including:
  - Fatigue risk management
  - Hours of service (HOS) for transit workers
  - Route and personnel scheduling
  - Medical examination certificates
  - Testing for sleep disorders
  - Training
- Identify gaps that may exist in standards, recommended practices, or guidance documents available to the industry to address medical fitness for duty and fatigue

- Present findings to FTA for its consideration related to the development or issuance of voluntary standards, protocols, guidelines, or recommended practices related to medical fitness for duty and fatigue risk management

Due to the significance of these topics and the interrelatedness of many of the subtopics included in this examination, the research efforts and associated narrative and findings are presented under the following headings:

- Medical Fitness for Duty
  - Medical Examinations – Elements, Practices, Frequency
  - Testing for Sleep Disorders and Associated Practices
  - Recognition and Reporting of Sleep Disorders
- Fatigue Risk Management
  - HOS
  - Transit Worker Scheduling
  - Transit Route Scheduling
  - Training to Recognize Signs/Symptoms
  - Fatigue-related Distractions, Including Cognitive Overload
  - Use of Biomathematical Models and Other Tools to Predict or Identify Fatigue or Fatigue-related Conditions

This report provides findings from background research and a literature review and reflects input from CUTR's Transit Standards Working Group. A separate report, *Over the Counter and Prescription Drug Use in the Public Transit Industry*, covers the use and/or misuse of prescription (Rx) and over-the-counter (OTC) medications, including:

- Effects of Rx and OTC medications that are cause for concern
- Education of safety-sensitive employees
- Policies that promote reporting of medication use
- Employee reporting of Rx and OTC medication use
- Use of Medical Assessment Officer (MAO) evaluation of reported medication use
- Agency protocols following MAO determination
- Development of protocols for addressing Medical Review Officer (MRO) significant safety concerns related to an employee's medication use or medical condition identified through an FTA-required urine drug test
- Addressing medication use on a routine, periodic basis
- Application of standards

Background

The Moving Ahead for Progress in the 21st Century Act (MAP-21) and its successor, the Fixing America's Surface Transportation (FAST) Act, prompted FTA to establish a Safety Management System (SMS) framework as the basis for its National Public Transportation Safety Program (49 USC Section 5329). SMS is a formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of a transit agency's safety risk mitigation. SMS includes systematic procedures, practices, and policies for managing risks and hazards.[2] As codified in 49 Code of Federal Regulations (CFR) Part 673, each transit agency must establish and implement an SMS that incorporates the following elements:

- Safety Management Policy
- Safety Risk Management (SRM)
- Safety Assurance
- Safety Promotion

SRM is a process used to assess a transit agency's risks and verify that systems are in place to control that risk. The process identifies hazards, assesses those hazards, identifies consequences of the hazards, and establishes the controls to manage risks.

Hazards can be identified during routine safety and security monitoring and evaluation activities, employee safety reporting, and agency performance and safety and security data and through accident investigations. In several National Transportation Safety Board (NTSB) accident investigation reports, fatigue, medical fitness for duty, and other related factors were indicated as causal or contributing to fatal events and are the source of recommendations to US Department of Transportation (US DOT) Modal Administrations dating back to 1989, as detailed in Appendix C. NTSB's 2019–2020 Most Wanted List of Transportation Safety Improvements includes the following fatigue and medical fitness for duty-related topics:

- Eliminate Distractions
- Reduce Fatigue-related Accidents
- End Alcohol and Other Drug Impairment
- Require Medical Fitness – Screen for and Treat Obstructive Sleep Apnea (OSA)

This research is relevant and timely, addressing areas for which voluntary standards, recommended practices, and guidance are needed within the public transit industry.

[2] *Federal Register*, 83(139), July 19, 2018, p. 34428. 49 CFR Part 673, Public Transportation Agency Safety Plan Final Rule, § 673.5, Definitions.

Catastrophic events may be avoided if a transit operator, maintenance technician, dispatcher, or other transit employee responds promptly and effectively to safety-critical tasks occurring during routine daily operations. Any safety-sensitive employee who is not medically fit for duty or is fatigued may not be able to effectively perform these safety-critical tasks and, therefore, may jeopardize their own safety or that of other transit agency personnel, riders, or the traveling public. Safety-sensitive functions are defined in FTA Title 49 CFR 655.4 as any duty, when performed by employees of recipients, subrecipients, operators, or contractors, that includes:

- Operating a revenue service vehicle, including when not in revenue service
- Operating a non-revenue service vehicle when required to be operated by a holder of a Commercial Driver's License
- Controlling dispatch movement of a revenue service vehicle
- Maintaining a revenue service vehicle or equipment used in revenue service. (*Note:* This part of the definition does not apply to an employer that receives funding under 49 USC 5307 or 5309, is in an area of less than 200,000 in population or receives funding under 49 USC 5311 and contracts out such services.)
- Carrying a firearm for security purposes[3]

Research related to medical fitness for duty included an examination of medical examination certification/certificate regulations issued by US DOT Modal Administrations and regulations, laws, or directives prescribed by state DOTs, State Safety Oversight Agencies (SSOAs), or other state or regional authorities or those required locally. CUTR examined fatigue risk management including the recognition, reporting, or testing for sleep disorders, training programs that address these areas, and cognitive overload factors. This research also included a review of HOS regulations and standards.

The project team used several sources of standards, guidelines, and recommended practices from which to draw content, including the following:

- "Review and Evaluation of Public Transportation Safety Standards" (FTA Report No. 0103) and the associated "Transit Safety Standards Compendium"
- NTSB recommendations to FTA, public transportation agencies, and other US DOT Modal Administrations
- Reports and associated recommendations to other US DOT Modal Administrations, such as FMCSA, FRA, and the Federal Aviation Administration (FAA)

[3] https://www.govinfo.gov/content/pkg/CFR-2009-title49-vol7/pdf/CFR-2009-title49-vol7-sec655-4.pdf.

- Research reports issued by TRB, TCRP, University Transportation Centers (UTC) Program members, and other research bodies (including state DOTs)
- Standards and recommended practices in use by the US transit industry, such as recommended practices developed through APTA's Standards Program
- Federal regulations
- Existing state laws and regulations, including those established by the State of Florida and the California Public Utilities Commission (CPUC)

Section 2

Industry Data

The National Transit Database (NTD) is the reporting platform for FTA transit agency grantees. NTD's Safety and Security Major-Only Time Series dataset, reported on the Safety and Security (S&S) 40 form, does not identify causal or contributing factors to major transit events; therefore, there is no aggregated national transit data that can account for injury and fatality events that may have been due to or influenced by fatigue or illnesses or conditions associated with medical fitness for duty.

FTA's 2021 "Rail Safety Data Report" presents rail transit agency (RTA) data provided to FTA through SSOAs for 2007–2018. Probable cause data are included, categorized as:

- Workforce or Infrastructure
- Customer Behavior
- Public Behavior
- Other (includes "medically-related" and "other" causes that do not fit into the three categories above)

Table 2-1 illustrates RTA reportable events and rates associated with these probable cause categories. Although not specifically addressed, events classified as "Other" that are medically-related could be associated with fatigue or medical fitness for duty-related illnesses or conditions. However, there are insufficient data to confirm this assumption.

For RTAs, FTA's *Program Standard Technical Assistance Guide*, developed to support compliance with 49 CFR Part 674, details SSOA accident investigation report expectations. If a transit operator is involved in an event, "operator status" should include a fatigue evaluation. The guidance includes the reporting of causal factors and other accident investigation event findings to the SSOA. Although the data are limited, the findings from these rail transit investigations will become a source for more robust causal or contributing factor data in the future.

Although current US public transit data are limited, there are sources of data both within and outside the US that document fatigue-related events in the transportation industry, such as NHTSA's Fatality Analysis Reporting System (FARS) or Crash Investigation Sampling System (CISS),[4] the FMCSA Large Truck Crash Causation Study Database, the FRA Crash Database,[5] and the Government of New South Wales Fatigue and Distracted Driver Trauma Trends.[6]

[4] https://www.nhtsa.gov/crash-data-systems/crash-investigation-sampling-system.
[5] https://safetydata.fra.dot.gov/OfficeofSafety/default.aspx.
[6] https://roadsafety.transport.nsw.gov.au/downloads/trauma-trends-fatigued-distracted-driving.pdf.

FARS is a nationwide census providing data regarding fatal injuries suffered in motor vehicle crashes.[7] Data are included in FARS only if at least one fatality occurred within 30 days as a result of the traffic crash; therefore, this database is not representative of the entire driving population but is representative of the characteristics of the most severe collisions. FARS data are obtained from various documents including:

- Police crash reports
- Death certificates
- State vehicle registration files
- Coroner/Medical Examiner reports
- State driver licensing files
- State highway department data
- Emergency medical service reports
- Vital statistics and other state records

As such, many variables such as determination of driver impairment due to being asleep or fatigued are often underreported due to lack of evidence available to emergency first responders. Unlike alcohol or drug use, fatigue or sleepiness cannot be determined by any postmortem testing. Even with such data collection limitations, the number of drivers involved in fatal traffic crashes that are determined to be impaired due to being asleep or fatigued remained above 700 per year for 2010–2017, falling to 694 in 2018, as shown by the red line in Figure 2-1. The blue line in the figure indicates the share of asleep/fatigued impaired drivers involved in fatal crashes. Although the trend has been generally decreasing over the past eight years, the problem is persistent. Additionally, it is important to note that there are other driver impairment classifications that may be included in fatigue analyses due to the similarities in the evidentiary characteristics of a fatal collision. For example, NHTSA combines drowsy, asleep, fatigued, ill, or blackout into the same impairment category in its annual table of Related Factors for Drivers Involved in Fatal Crashes.[8]

[7] https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars.
[8] https://www-fars.nhtsa.dot.gov/People/PeopleDrivers.aspx.

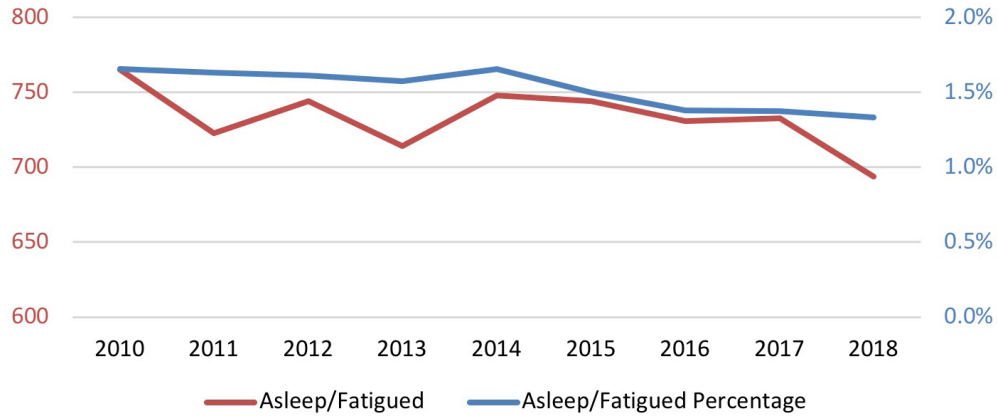
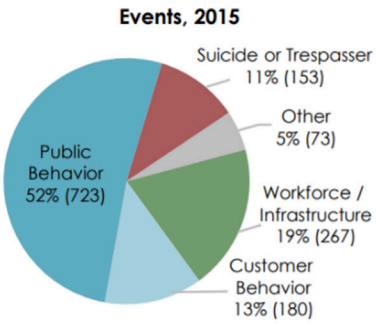
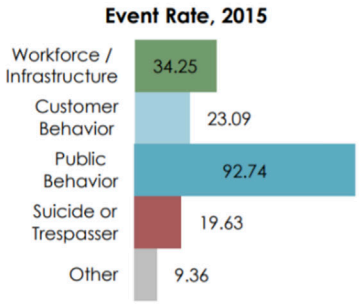


Figure 2-1 *Asleep/fatigue-impaired drivers involved in fatal crashes*

Source: FARS

Table 2-1 *RTA Events and Rates by Probable Cause (100M VRMs)*





	2007	2008	2009	2010	2011	2012	2013	2014	2015	Avg	Trend
Workforce / Infrastructure	195	218	210	149	148	126	185	172	267	185.6	
Customer Behavior	71	65	66	128	128	137	152	155	180	120.2	
Public Behavior	469	675	731	625	617	644	690	724	876	672.3	
Suicide or Trespasser	106	109	157	130	135	143	151	133	153	135.2	
Other	34	13	22	121	139	93	72	61	73	69.8	

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Avg	Trend
Workforce / Infrastructure	27.42	29.77	28.16	20.44	20.54	17.29	24.57	22.70	34.25	25.08	
Customer Behavior	9.98	8.88	8.85	17.55	17.77	18.80	20.19	20.46	23.09	16.25	
Public Behavior	65.95	92.19	98.01	85.72	85.65	88.38	91.65	95.56	112.4	90.89	
Suicide or Trespasser	14.91	14.89	21.05	17.83	18.74	19.62	20.06	17.56	19.63	18.28	
Other	4.78	1.78	2.95	16.59	19.29	12.76	9.56	8.05	9.36	9.43	

Source: FTA

NHTSA released a brief statistical summary, "Drowsy Driving 2015," in October 2017[9] that reported that drowsy driving was involved in 2.3–2.5% of all fatal crashes nationwide for 2011–2015 (Table 2-2). These statistics have inherent limitations that are recognized as underreported due to lack of evidence, yet the extent of underreporting is statistically unknown. Additionally, as it relates

[9] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812446.

to commercial operators, NHTSA recognizes people with untreated sleep disorders, shift workers, and public safety personnel as higher risk populations for drowsy driving.[10]

Table 2-2 *Drowsy Driving by Year, 2011–2015*

Year	Total Fatal Crashes			Fatal Crashes Involving Drowsy Driving					
	Crashes	*Drivers*	*Fatalities*	*Crashes*		*Drivers*		*Fatalities*	
	#	#	#	#	%	#	%	#	%
2011	29,867	43,840	32,479	721	2.4	723	1.6	810	2.5
2012	31,006	45,664	33,782	744	2.4	744	1.6	835	2.5
2013	30,202	44,803	32,893	714	2.4	713	1.6	801	2.5
2014	30,056	44,671	32,744	747	2.5	747	1.7	851	2.6
2015	32,166	48,613	35,092	736	2.3	736	1.5	823	2.3
2011–2015	153,297	227.591	166,990	3,663	2.4	3,663	1.6	4,121	2.5
5-Yr Avg	30,659	45,518	33,398	732	2.4	733	1.6	824	2.5

Source: NHTSA 2017

[10] https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/drowsydriving_strategicplan_030316.pdf.

Section 3

Literature Review

The research team performed a literature review of research reports and guidance documents that focus on medical fitness for duty and fatigue risk management, including driver fatigue, HOS contributions to fatigue, transit worker scheduling, transit route scheduling, training to recognize the signs and symptoms of fatigue, fatigue related distractions including cognitive overload, and the use of biomathematical models and other tools to predict or identify fatigue-related conditions. Other factors related to medical fitness for duty, driver wellness, sleep disorders, and other related content also were examined. The comprehensive literature review is provided as Appendix A and includes various definitions of fatigue, followed by findings associated with the numerous fatigue contributors and factors.

Existing Regulations and Standards

Federal Regulations

- **FRA** – Title 49 CFR 228, HOS for Railroad Employees prescribes reporting and recordkeeping requirements related to HOS requirements for train employees engaged in commuter or intercity rail passenger transport and establishes minimum standards for sleeping quarters.[11] Title 49 CFR 228.405 defines the specific limitations for on-duty hours of train employees engaged in commuter or intercity rail passenger transportation as a minimum of 8 consecutive hours off duty during the prior 24 hours, a minimum of 10 consecutive hours off duty after working 12 consecutive hours, and no more than 14 consecutive calendar days on duty, with additional specific exemptions. Title 49 CFR 228.407 requires the analysis of work schedules as a required element in the mandatory fatigue mitigation plans. Title 49 CFR 228.411 details the requirement of training for railroad employees and supervisors, which must include physiological and human factors that affect fatigue as well as strategies to reduce or mitigate the effects of fatigue; opportunities for identification, diagnosis, and treatment of any medical condition that may affect alertness or fatigue, including sleep disorders; alertness strategies, such as policies on napping, to address acute drowsiness and fatigue while an employee is on duty; opportunities to obtain restful sleep at lodging facilities, including employee sleeping quarters provided by the railroad; and the effects of abrupt changes in rest cycles for employees.
- **FMCSA** – Title 49 CFR 395, HOS for Drivers establishes the maximum driving time for both property-carrying and passenger-carrying vehicles.[12] Title 49

[11] http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title49/49cfr228_main_02.tpl.
[12] https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&ty=HTML&h=L&mc=true&=PART&n=pt49.5.395.

CFR 395.3 establishes maximum driving time for property-carrying vehicles as no more than 11 hours, with a maximum time on duty for all functions including driving of 14 hours following a minimum of 10 consecutive hours off duty.[13] Title 49 CFR 395.5 establishes maximum driving time for passenger-carrying vehicles as no more than 10 hours driving time following 8 consecutive hours off duty, or for any period after having been on duty for 15 hours following 8 consecutive hours off duty; no more than 60 on duty hours in 7 consecutive days; and no more than 70 hours in 8 consecutive days. These regulations also require the documentation of duty status to allow for compliance monitoring.

- **USCG** – Title 46 CFR 15, Marine HOS Requirements[14] prescribes required compliance with 46 USC 8104, which sets limitations on the working hours of credentialed officers and crew members.[15] These HOS limits vary by vessel, type, task assignment, and vessel location and generally limit HOS for ocean-going vessels not more than 100 gross tons to 12 of 24 hours while at sea and no more than 9 of 24 hours while in port. There are separate HOS rules for towing vessels operated in the Great Lakes, merchant vessels greater than 100 tons, and tankers.
- **FAA** – Title 14 CFR 91.1059, Flight Time Limitations and Rest Requirements: One or Two Pilot Crews establishes limitation of flight time to be no more than 500 hours in any calendar quarter, 800 hours in two consecutive calendar quarters, 1,400 hours in any calendar year, 8 hours in any 24 consecutive hours for a one-pilot flight crew, and 10 hours in any 24 consecutive hours for a two-pilot flight crew.[16] A minimum of 10 hours of rest is required immediately before duty, on duty time may not exceed 14 hours, and minimum rest after duty is 10 hours.
- **FMCSA** – Title 49 CFR 390 Subpart D National Registry of Certified Medical Examiners establishes minimum qualifications for FMCSA certification of a Medical Examiner to ensure their ability to perform medical examinations of operators for subsequent certification as fit for duty.[17] Title 49 CFR 390.103 requires medical examiners be licensed, certified, and registered on the National Registry and have satisfactorily completed Medical Examiner training and passed examiner certification testing.
- **FAA** – Title 14 CFR 67 Subpart B First Class Airman Medical Certificate describes the eligibility requirements for first-class airman, including visual acuity of 20/20 or better, the ability to see colors, and normal fields

[13] https://www.ecfr.gov/cgi-bin/retrieveECFR?gp-1&ty-HTML&h-L&mc-true&-PART&n-pt49.5.395#se49.5.395_13.
[14] https://www.ecfr.gov/current/title-46/chapter-I/subchapter-B/part-15/subpart-G#15.710.
[15] https://www.govinfo.gov/app/details/USCODE-2011-title46/USCODE-2011-title46-subtitleII-partF-chap81-sec8104.
[16] https://www.govinfo.gov/app/details/CFR-2012-title14-vol2/CFR-2012-title14-vol2-sec91-1059.
[17] http://www.ecfr.gov/cgi-bin/text-idx?SID=c4aa6f384834e3c245384d9e6b561f0e&mc=true&node=sp49.5.390.d&rgn=div6.

of vision (67.103); acceptable hearing along with no ear, nose, or throat diseases or conditions that may impair equilibrium or ability to verbally communicate (67.105); mental standards with no history of personality disorders, psychosis, bi-polar disorder, or substance dependence (67.107); neurologic standards with no history or diagnosis of epilepsy, loss of consciousness, or loss of nervous system functions (§67.109); cardiovascular standards with no myocardial infraction, angina pectoris, coronary heart disease, cardiac valve replacement, or heart replacement (67.111); and general medical condition standards with no history or diagnosis of insulin-dependent diabetes or other functional or structural disease, defect, or limitation (67.113).[18]

Table 3-1 compares 49 USC 211, Hours of Service,[19] with FRA 49 CFR Part 228, Hours of Service of Railroad Employees.[20] Title 49 USC 211 defines the limitations of on-duty hours of train employees (21103), signal employees (21104), and dispatching employees (21105). Each of these limitations restricts train, signal, and dispatching employees from working more than 12 hours in 24 hours, with emergency exceptions that allow for up to 16 hours on duty. Additionally, 49 USC 211 requires that train, signal, and dispatch employees are provided with a minimum of 8 hours off between shifts and a minimum of 10 hours off between shifts of 12 consecutive hours. Finally, train employees are limited to no more than 6 consecutive workdays; FRA HOS regulations similarly call for no more than 12 hours on duty, with specific 16-hour on-duty-specific exemptions, at least 8 hours off between shifts, and a minimum of 10 hours off if the employee worked 12 consecutive hours. Within Title 49 CFR 228.405, train employees are permitted to work up to 14 consecutive days. There are certain circumstances in which FRA will not take enforcement action for HOS violations, such as in 49 CFR 219.12, where the sole cause of the violation is attributed to post-accident toxicological testing or reasonable suspicion testing.[21]

Table 3-2 shows a comparison of the elements included in federal medical examination regulations issued by FMCSA, FRA, and FAA. FAA is most stringent in renewal frequency (annual); FRA and FMCSA require medical examination certification renewal every two years. All three US DOT Modal Administrations require that medical examinations include physical qualifications of the assigned duty, visual acuity, and no hearing loss. FAA is most stringent, also requiring that colorblindness tests be included in medical examination certification reviews. Additional medical examination elements include testing for diabetes, mental disorders, and alcohol and drug use, as shown in Table 3-2.

[18] https://ecfr.federalregister.gov/current/title-14/chapter-I/subchapter-D/part-67#subpart-B.
[19] https://www.govinfo.gov/app/details/USCODE-2011-title49/USCODE-2011-title49-subtitleV-partA-chap211.
[20] https://www.govinfo.gov/app/details/CFR-2009-title49-vol4/CFR-2009-title49-vol4-part228.
[21] https://www.govinfo.gov/content/pkg/CFR-2017-title49-vol4/pdf/CFR-2017-title49-vol4-sec219-12.pdf.

Table 3-1 *HOS Regulations*

Regulating Agency	Name	Date	Regulation	Max Work Time (per 24 Hrs)	Max Consec. Hrs	Min Time Off Between Shifts If Worked 12 Consec. Hrs	Min. Off Time Between Shifts	Max Consec. Work Days
FRA	HOS of railroad employees	2009	49 CFR §228	12 hrs (16 hrs with specific exemptions)	12 hrs (16 hrs with specific exemptions)	10 hrs	8 hrs	6 days
FRA	Limitations on duty hours of train employees engaged in commuter or intercity rail passenger transportation	2011	49 CFR §228.405	12 hrs		10 hrs	8 hrs	14 days
FRA	HOS limitations: [22] • train employees • signal employees • dispatching service employees	2011	49 USC 211: §21103 §21104 §21105	12 hrs	16 hrs with emergency exceptions	10 hrs	8 hrs	6 days (§21103 only)
FMCSA	HOS for passenger-carrying vehicles[23]	2019	49 CFR §395.5	15 hrs		10 hrs	8 hrs	
USCG	Marine HOS requirements (ocean-going or coastwise vessel of not more than 100 gross tons)[24]	2014	46 CFR §15.710	9 hrs in port/ 12 hrs at sea	Undefined emergency exceptions		6 of preceding 12 hrs	
FAA	Flight time limitations and rest requirements (1 or 2-pilot crews)[25]	2020	14 CFR §91.1059	14 hrs	8 hrs (1 pilot)/ 10 hrs (2-pilot crew)		10 hrs	

[22] https://www.govinfo.gov/content/pkg/USCODE-2011-title49/pdf/USCODE-2011-title49-subtitleV-partA-chap211.pdf.
[23] https://www.govinfo.gov/content/pkg/CFR-2019-title49-vol5/pdf/CFR-2019-title49-vol5-sec395-5.pdf.
[24] https://www.govinfo.gov/content/pkg/USCODE-2014-title46/html/USCODE-2014-title46-subtitleII-partF-chap81.htm.
[25] https://www.govinfo.gov/app/details/CFR-2020-title14-vol2/CFR-2020-title14-vol2-sec91-1059.

Table 3-2 *Federal Medical Examination Guidance Elements*

Federal Agency	Regulation	Title	Employee Type	Medical Provider	Frequency	Physically Qualified	Diabetes	Considers Current Medical Diagnoses	No Medical History of Disease	No Mental/ Psychiatric Disorder	Visual Acuity	Color-blindness	No Average Hearing Loss	No Drug or Substance Use	No Alcoholism Diagnosis
FMCSA	49 CFR: §391.41 §391.43	• CLP/CDL Physical Qualifications for Drivers • Certificate of Physical Examination	Commercial Drivers		2 yrs	X	X	X	X	X	X		X	X	X
FRA	49 CFR §242.117	FRA Conductor Vision and Hearing Acuity	Conductors, Engineers	X	2 yrs	X					X		X		
FAA	14 CFR§67.103: §67.105 §67.107 §67.111	Eye, Ear, Nose, Throat, and Equilibrium – Mental – Cardiovascular	Pilots/ Co-Pilots	X	Annual	X	X	X	X	X	X	X	X	X	X

Federal Guidance Documents/Resources

FRA's "Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules – Summary Report" details a project undertaken to demonstrate a method to validate and calibrate a fatigue model for the railroad industry.[26] The biomathematical fatigue model was validated through the existence of a linear relationship between crew effectiveness and the risk of a human factor-accident, a relationship not present in non-human factor accidents. The study also found that the risk associated with a blood alcohol level (BAC) of 0.08 was equivalent being awake for 21 hours following an 8-hour sleep period.

"Fatigue Management Survey Results" (2006) summarized the results of an FTA survey developed in response to NTSB Safety Recommendation R-06-03 to FTA, which recommends that FTA require transit agencies to provide train operators with adequate time off duty to obtain at least 8 hours of uninterrupted sleep.[27] The report detailed survey response results from 22 SSOAs and 37 RTAs, of which 65% limited duty hours to 14 hours or less with at least 10 hours off duty between shifts and 35% allowed operators to work up to 16 hours per day. Additionally, more than half of the agencies that allowed up to 16-hour workdays had established napping policies and quiet rooms available to operators when not on active duty.

FRA Safety Advisory 2004–04 suggested five measures that railroads and employees should use to prevent work-related errors and on-the-job accidents as a result of sleep disorders:[28]

- Establish training to inform employees of the potential for performance impairment as a result of fatigue and incorporate self-assessment, peer-to-peer communication, and co-worker identification elements accompanied by consistent policies.
- Ensure that employee medical examinations include screening for sleep disorders, develop standardized screening tools and guidance for consistent medical examinations, and provide a list of sleep disorder centers and related specialists.
- Develop and implement rules to request safety-sensitive employees to voluntarily report sleep disorders.
- Develop and implement policies that prohibit employees with sleep-related performance-impairing medical conditions from performing safety-sensitive duties until that medical condition appropriately responds to treatment.

[26] https://www.fra.dot.gov/eLib/details/L02535.
[27] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/fm_survey.pdf.
[28] https://www.federalregister.gov/documents/2004/10/01/04-22025/notice-of-safety-advisory-2004-04-effect-of-sleep-disorders-on-safety-of-railroad-operations.

- Implement policies to promote self-reporting of sleep-related medical conditions, encourage employees with diagnosed sleep disorders to participate in evaluation and treatment, and establish dispute resolution mechanisms to rapidly resolve fitness for duty issues of employees who have reported sleep-related medical conditions.

FTA's Transit Advisory Committee for Safety (TRACS) developed Report 14-02, "Establishing a Fatigue Management Program for the Bus and Rail Transit Industry," which highlights the complex issues associated with transit operator fatigue and the challenges that may be faced in addressing transit employee fatigue.[29] TRACS cited 1990 NTSB research that revealed that fatigue played a role in 31% of heavy truck vehicle crashes, which suggested that about a third of all bus and rail transit accidents or near-misses were related to operator fatigue.[30] A specific recommendation was made that "transit agencies provide mandatory fatigue awareness training and mandate medical health screenings at intervals of no more than one year for all safety-sensitive personnel and collect and track fatigue performance measures."[31] The report also concluded that transit worker fatigue remains a serious problem for the whole industry, requiring an SMS approach to preventing fatigue-related incidents.

The Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) model of human fatigue and circadian variation and the Fatigue Avoidance Scheduling Tool (FAST) application were developed through sponsored efforts of US DOT and the US Department of Defense. In 2006, FRA completed a test of the model and found that model predictions of decreased operator effectiveness were related to increased human factors accident risk.[32] The FAST application and SAFTE model estimate fatigue risk, show details of each schedule, calculate fatigue factors, and identify conditions that may lead to fatigue so mitigations can be implemented. Background research indicates that the FAST application is a valuable tool to manage fatigue in safety-sensitive public transportation positions.

FRA and FMCSA have studied Obstructive Sleep Apnea (OSA) and its role as a factor in rail and motor carrier incidents. In March 2016, FRA issued an Advanced Notice of Proposed Rulemaking (ANPRM) on OSA[33] and requested data and information related to the prevalence of moderate-to-severe OSA and the potential consequences of this disorder on rail and highway safety. (*Note:* This ANPRM was withdrawn in March 2018, but joint efforts between FMCSA and FRA

[29] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/TRACS_Fatigue_Report_14-02_Final_(2).pdf.
[30] https://www.ntsb.gov/safety/safety-studies/Documents/SS9001.pdf; https://www.ntsb.gov/safety/safety-studies/Documents/SS9002.pdf.
[31] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/TRACS_Fatigue_Report_14-02_Final_(2).pdf.
[32] https://ibrinc.org/wp-content/uploads/2016/06/validation-and-calibration-summary-report.pdf.
[33] https://www.fra.dot.gov/eLib/Details/L17364.

are still underway to address the issue.) Although the ANPRM did not address a specific operational or personnel standard related to the topic (nor the efficacy of a given standard or protocol), it did provide several examples of railroad and highway accidents for which NTSB investigations were conducted. In the examples provided, NTSB determined that OSA played a role in causing accidents (or near-accidents) involving motor carriers and trains. These examples were used to illustrate the risks associated with moderate-to-severe OSA. More details regarding this NTSB recommendation and other NTSB recommendations related to fatigue and fitness for duty are provided in Appendix C.

FRA also sponsors the "Railroaders' Guide to Healthy Sleep," a resource website developed by the Volpe National Transportation Systems Center to inform the railroad industry about the importance of sleep health. Railroad workers can access an Anonymous Sleep Disorders Screening Tool to determine if they have symptoms that may suggest a possible sleep disorder. The site includes interviews and videos of railroad employees, their families, and experts in sleep medicine. Other tools are available to measure overall sleepiness, including a sleep-wake diary to track sleep patterns over time and assistance for railroad workers to find sleep specialists in their area through the American Academy of Sleep Medicine.

FMCSA worked with other US and Canadian agencies to develop the North American Fatigue Management Program (NAFMP), which provides materials, guidelines, standards, and processes to enable motor carriers to implement a comprehensive and effective Fatigue Management Program (FMP).[34] In 2010, NTSB referenced the NAFMP:

> To be most effective, a fatigue management program should be comprehensive and authoritative. Within the next two years, the NAFMP is expected to provide fatigue management program guidelines specifically designed for use in the motor carrier environment. Implementation of these guidelines by every motor carrier would be a major step toward addressing the problem of fatigue among commercial drivers on the nation's highways. But if the NAFMP guidelines remain voluntary and are used by some carriers but ignored by others this important safety tool might have only a limited effect in reducing fatigue-related highway accidents. Consequently, NTSB recommends that the FMCSA require all motor carriers to adopt a fatigue management program based on the NAFMP guidelines for the management of fatigue in a motor carrier operating environment.[35]

[34] https://www.fmcsa.dot.gov/research-and-analysis/research/north-american-fatigue-management-program.

[35] National Transportation Safety Board Safety Recommendation, October 21, 2010. In Reply, refer to H-10-8 through -11 and H-08-13 and -14.

NAFMP learning modules are described in Appendix B of this report.

Additional process applications can be drawn from FAA. Under new guidance issued in 2015, Aviation Medical Examiner screening processes for pilots include the opportunity to require further evaluations to determine if OSA is a risk factor for an individual. These examples and the activities of FTA's Modal Administration peers should be considered by FTA when establishing standards or protocols related to fatigue.

Consensus Standards

- APTA-RT-OP-S-018-12 Rev 1: Fitness for Duty (FFD) Program Requirements[36] – APTA first published this standard in December 2012, with the first revision released in January 2019. The standard applies to rail transit agencies that operate light rail, heavy rail, streetcar, or rail subway systems, but it is not applicable to commuter rail properties that are regulated by FRA. The standard was developed to establish baseline requirements for a fitness for duty program so rail transit systems can formalize physical job duty performance abilities prior to and continually monitor throughout employment. The standard includes seven sections related to the creation of a fitness for duty program, pre-selection requirements, assessment of trainee fitness for duty during training, on-the-job requirements, program administrative requirements, training and awareness, and program management.
- APTA-RT-OP-S-018-12 Rev 1 guides RTAs to develop a fitness for duty program that applies to any employee that operates, or has the potential to operate, a train in revenue service. The APTA standard also suggests that RTAs consider applicability of the fitness for duty program to other safety-sensitive employees.

State Regulations

Many states have instituted minimum medical examination requirements in statewide statutes or administrative codes, some of which adopt federal regulations by reference, such as FMCSA-regulated 49 CFR 391.41–391.49. The variance in elements included in the state guidance is shown in Table 3-3.

[36] https://www.apta.com/research-technical-resources/standards/rail/apta-rt-op-s-018-12/.

Table 3-3 *State Medical Examination Elements*

State	Policy	Mode	Pre-Employment	Frequency	Drug & Alcohol	Return to Duty	Impaired or Likely to be impaired
CA	CPUC General Order 143-B	Light rail	X	2 yrs	X		
CT	CT Statute Sec. 14-44 (refers to 49 CFR 391.41–391.49	Passenger-carrying commercial operators	X	2 yrs	X	X	
FL	Florida Administrative Code 14.90.0041	Transit bus	X	2 yrs		≥ 30 days	
ME	49 CFR 391.41–391.49	Commercial operators	X	2 yrs			
MN	49 CFR 391.41–391.49	Commercial operators	X	2 yrs	X	X	
NJ	Over 70 = N.S.S.18A:39-1 NJ Rev Stat §39:3-10.1	Passenger-carrying commercial operator	X	Annual	X	X	X
NY	New York, Section 509-D New York, Section 509-K	Commercial operators	X	2 yrs			X
OH	49 CFR 391.41	Commercial operators	X	2 yrs	X	X	

HOS limits established by various state and federal regulations for CDL holders are shown in Table 3-4. The most stringent state guidance limits drive time to 10 hours with no more than 15 hours on-duty time. The most stringent time off between shifts is in Connecticut, which requires a minimum of 10 hours off. However, for states that address hours off between shifts, the majority require a minimum of 8 hours off between shifts. Additionally, New York is the most restrictive regarding maximum work hours per week, with a maximum of 60 work hours per week. Title 49 CFR Part 395 provides FMCSA HOS regulations for both passenger- and property-carrying service.

Table 3-4 *State Guidance and Regulations for HOS*

State/Federal Code	Max Drive Time Hrs	Max Work Time Hrs	Min Off-Duty Hrs	Max Work Hrs per Week
FL	12	16	8	72
IL	12	15	8	70
CT	12	16	10	
MA	10		8	
CO	10	16	8	80 (8 days)
NY	10	15	8	60
CA	12	15	8	
MO			8	
UT	12	16	8	
VA	13			
49 CFR §395.3 (property carrying)	11	14	10	60
49 CFR §395.5 (passenger carrying)	10	15	8	60

Data from Outside US

In addition to FMCSA regulations, there are trucking industry HOS guidance and regulations issued by entities outside the US that may be considered when modifying existing practices or adopting HOS standards for public transit operators (Table 3-5). Maximum driving hours range from no more than 9 hours in the European Union (EU) to no more than 13 hours in Canada. Minimum off-duty time ranges from seven hours in Australia to a minimum of 11 hours off in the EU. Maximum workday hours, including split shifts, range from 12 hours in Australia to 14 hours in Canada. US maximum driving hours per week range from 56 hours in the EU to 72 maximum hours in Australia, as shown in Table 3-5.

Table 3-5 *HOS Limits in Trucking Industry*

Country/ Region	Max Driving Hrs	Max Workday Hrs	Off-Duty Hrs	Maximum Hrs per Week
US (FMCSA)[37]	11	14	8	60
Canada[38]	13	14	10	70
Australia[39]	12	12	7	72
EU[40]	9		11	56

National Transportation Safety Board Recommendations

As noted, NTSB's 2019–2020 Most Wanted List of Transportation Safety Improvements includes fatigue and medical fitness for duty-related topics:

- Eliminate Distractions
- Reduce Fatigue-related Accidents
- End Alcohol and Other Drug Impairment
- Require Medical Fitness – Screen for and Treat OSA

On the topic of medical fitness associated with sleep apnea, NTSB indicates that:

> Undiagnosed and untreated obstructed sleep apnea continues to be deadly on our roads and rails, causing too many preventable accidents. We want to see mandatory screening and treatment for obstructive sleep apnea for rail and highway personnel in safety-sensitive positions.[41]

NTSB does not explicitly define safety-sensitive duties, as each Modal Administration is responsible for defining the positions designated as safety-sensitive. However, NTSB has made recommendations to FRA to revise its definition of a "covered employee" to encompass all safety-sensitive functions as described in 49 CFR 209.303,[42] which defines safety-sensitive employees as those assigned to perform service subject to the HOS Act (inclusive of dispatching, signal, and train employees); any person who inspects, installs, repairs, or maintains track and roadbed; any person who inspects, repairs, or maintains locomotives, passenger cars, and freight cars; any person conducting

[37] https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations.
[38] https://cvse.ca/national_safety_code/pdf/HOS_Service_Rules.pdf.
[39] https://www.nhvr.gov.au/safety-accreditation-compliance/fatigue-management/work-and-rest-requirements/standard-hours.
[40] https://ec.europa.eu/transport/modes/road/social_provisions/driving_time_en.
[41] https://www.ntsb.gov/safety/mwl/Pages/mwlfs-19-20/mwl8.aspx.
[42] https://www.ntsb.gov/news/events/Pages/Collision_of_Massachusetts_Bay_Transportation_Authority_Train_322_and_Track_Maintenance_Equipment_near_Woburn_Massachusett.aspx.

training and testing of employees; or any person who performs service subject to the Transportation of Hazardous Materials laws, or any regulation or order prescribed thereunder. This FRA definition of safety-sensitive employees includes managers, supervisors, or agents when they perform safety-sensitive functions or supervise/direct the performance of safety-sensitive functions.[43] FTA 49 CFR 655 defines a safety-sensitive function as any of the following duties when performed by employees of recipients, subrecipients, operators, or contractors: operating a revenue service vehicle, operating a nonrevenue service vehicle, controlling dispatch or movement of a revenue service vehicle, maintaining a revenue service vehicle or equipment used in revenue service, or carrying a firearm for security purposes.[44]

NTSB provides recommended actions to railroad and vehicle operators/industry and regulators and the medical community in support of reducing fatigue-related accidents with similar actions to address requiring medical fitness-screen for and treat OSA as follows:

- **Operators/Industry**
  - Establish fatigue risk management programs and continually monitor their success to reduce risks for personnel performing safety-critical tasks. These programs take a comprehensive, tailored approach to address the problem of fatigue within an industry or workplace. Such programs include policies or practices to address scheduling, attendance, education, medical screening and treatment, personal responsibility during non-work periods, task and workload issues, rest environments, commuting, and napping.
  - Collaborate to develop a model national labor agreement that supports effective programs for addressing sleep disorders and other medical conditions among safety-sensitive personnel.
- **Regulators**
  - Provide guidance to operators, transit authorities, and physicians to help them identify and treat individuals at high risk for OSA and other sleep disorders.
  - Require railroads to medically screen employees in safety-sensitive positions for OSA and other sleep disorders.
  - Implement a program to identify commercial drivers at high risk for OSA and require that they show evidence that they have been appropriately evaluated and treated before granting them unrestricted medical

[43] https://www.ecfr.gov/cgi-bin/text-idx?SID=80a3f0f350baef1a8020f9cd8131c556&mc=true&node=pt49.4.209&rgn=div5#se49.4.209_1303.
[44] https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=b111dc1ec5ace694671bfb2c13e1c217&r=PART&n=49y7.1.2.1.16#se49.7.655_14.

certification. Disseminate guidance for commercial drivers, employers, and physicians about identifying and treating OSA.

  - Using current fatigue science, provide initial and recurrent training on work schedule issues to mitigate risks that contribute to operator fatigue.
  - Develop medical certification regulations for employees in safety-sensitive positions that include, at a minimum, a complete medical history (including specific screening for sleep disorders, a review of current medications, and a thorough physical examination), standard testing protocols across the industry, and central oversight of certification decisions for employees who fail initial testing.
  - Consider requiring that medical examinations be performed by those with specific training and certification in evaluating medication use and health issues related to occupational safety on railroads.
  - Research new methods to identify fatigue and mitigate associated performance decrements for on-duty crews.
  - Develop and implement a plan to deploy in-vehicle technologies that reduce fatigue-related crashes.
  - Incorporate scientifically-based fatigue mitigation strategies into the hours-of-service regulations for passenger-carrying drivers who operate during the nighttime window of circadian low.

- **Medical Community**
  - Ensure that Board-certified physicians in family medicine receive enhanced and ongoing training so they can successfully identify risk factors for, evaluate, and treat OSA in their patients.[45]

NTSB issued a series of recommendations to various US DOT Modal Administrations and other groups in response to event investigation findings related to fatigue and medical fitness for duty. Appendix C includes a summary of NTSB investigation reports and corresponding recommendations.

In summary, NTSB fatigue-related recommendations to various industry stakeholders include limiting HOS, ensuring that an opportunity for rest is provided, revising schedules with the use of biomathematical models and the reduction of irregular work-rest cycles, and implementing training for fatigue awareness and recognition. In totality, NTSB recommends that the effects of fatigue on performance by safety-sensitive employees be considered in all aspects of an organization, including training and guidance, policy and procedural designs, schedule development, fitness for duty determinations, collision investigations, and audits or compliance reviews to manage risk due to fatigue in a holistic and preventative manner.

[45] https://www.ntsb.gov/safety/mwl/Pages/mwlfs-19-20/mwl2-fsr.aspx.

Medical fitness for duty-related NTSB recommendations to various industry stakeholders revolve around requiring safety-sensitive employees to divulge all diagnosed medical disorders; developing and implementing OSA identification programs and guidance for employees that are diagnosed with sleep disorders; developing and implementing policies, procedures, and audit processes to ensure that all safety-sensitive employees are fit for duty; and requiring that medical fitness for duty examinations be performed by approved and certified Medical Examiners. NTSB has also recommended that safety-sensitive personnel who have been diagnosed with chronic conditions such as OSA be required to submit to more frequent medical certification examinations. Additional medical fitness for duty recommendations include determining what constitutes a valid and reliable field test for color discrimination capabilities for employees in safety-sensitive positions and requiring the use of that field test once it has been deemed valid and reliable.

Medical fitness for duty-related NTSB recommendations to various industry stakeholders revolve around requiring safety-sensitive employees to divulge all diagnosed medical disorders; developing and implementing OSA identification programs and guidance for employees that are diagnosed with sleep disorders; developing and implementing policies, procedures, and audit processes to ensure that all safety-sensitive employees are fit for duty; and requiring that medical fitness for duty examinations be performed by approved and certified Medical Examiners. NTSB has also recommended that safety-sensitive personnel who have been diagnosed with chronic conditions such as OSA be required to submit to more frequent medical certification examinations. Additional medical fitness for duty recommendations include determining what constitutes a valid and reliable field test for color discrimination capabilities for employees in safety-sensitive positions and requiring the use of that field test once it has been deemed valid and reliable.

Agency Policies – State of the Practice

In addition to federal regulations, national best practices and guidance documents, and state administrative codes, transit agencies have adopted their own medical examination certification policies, often based on existing regulations or guidance, or a combination. The CUTR research team collected transit agency policies and procedures associated with medical examination certifications and HOS requirements.

Medical Examination Certification Agency Policies

Table 3-6 is a comparison of medical examination requirements for 10 US public transit agencies:

- Los Angeles County Metropolitan Transportation Authority (LA Metro), Los Angeles, CA
- Lane Transit District (LTD), Eugene, OR
- Metropolitan Atlanta Rapid Transit Authority (MARTA), Atlanta, GA
- Maryland MTA, Baltimore, MD
- Niagara Frontier Transportation Authority (NFTA), Buffalo, NY
- Port Authority of Allegheny County, Pennsylvania (Port Authority), Pittsburgh, PA
- Rio Metro Regional Transit District (Rio Metro), Albuquerque, NM
- Sacramento Regional Transit (SacRT), Sacramento, CA
- Southeastern Pennsylvania Transportation Authority (SEPTA), Philadelphia, PA
- Tri-County Metropolitan Transportation District of Oregon (TriMet), Portland, OR

These agencies require that all safety-sensitive employees be examined for medical fitness for duty prior to employment and certification and must be renewed with CDL renewals for safety-sensitive employees with CDLs. For those that require a medical examination certification for general return to duty, the maximum time off prior to requiring recertification ranges from three consecutive days to six months. These agency policies are described in detail in Table 3-6.

Table 3-6 *Agency Medical Examination Certification Requirements*

Transit Agency	Pre-Employment	Safety-Sensitive	Transfer to New Position	Before Rehiring	Renewal of Medical Certificate for CDL	Post-Accident	Fitness for Duty	OTC Medication	Return to Duty				
									Return to Duty (General)	*After 30 Days or Longer of Military Leave*	*For a Non-Occupational Medical Leave of 30 Days or More*	*For a Non-Occupational Injury or Illness that Required Hospitalization*	*If Employee Experienced a Medical Episode That Suggests Serious Potential Safety Risks*
LA Metro	X	X	X	X	X		X	X	≥ 30 days	X	X	X	X
LTD	X	X	X	X	X		X					X*	X*
MARTA	X	X		X	X		X		≥ 90 days			X	X
Maryland MTA	X	X	X	X	X	X	X	X	≥ 90 days				X*
NFTA	X	X		X	X	X	X					X*	X*
Port Authority	X	X	X	X	X		X	X	≥ 8 days			X	X
Rio Metro	X	X			X				≥ 3 cons. days			X	X
SacRT	X	X	X	X	X	X	X	X	≥ 90 days		X	X	X
SEPTA	X	X			X		X						
TriMet	X	X		X	X	X	X		≥ 6 mos	X	X	X	X

** Case-by-case basis*

LA Metro

LA Metro implemented Policy HR 29, Fitness for Duty to ensure that employees/job candidates are physically and mentally able to perform their essential duties without posing a health or safety risk to themselves, co-workers, or the public, through established standards. Fitness for duty medical examinations are required either in response to evidence indicating a lack of fitness or under routine situations such as:

- Pre-employment, as a condition of hire for safety-sensitive and physically demanding positions
- Transfer into a position with different physical requirements
- Before re-hire or reinstatement
- Renewal of medical certification for CDL
- Before returning to duty after 30 days or longer of leave (inclusive of medical leave, military leave, etc.)
- Before returning to work after experiencing an injury, illness, or medical episode.

All LA Metro-required medical examinations must be administered by a contracted LA Metro healthcare provider. Policy HR 29 also delineates the procedures for special fitness for duty evaluations in response to observed performance impairment and an explanation of fitness for duty determination alternatives (fit for duty, fit for duty with restrictions, unfit for duty, and permanently unfit for duty).

LA Metro's Policy HR 29 requires safety-sensitive employees to notify supervisors when they may not be fit for duty, including when impairment is due to prescription Rx and OTC medications. Safety-sensitive employees must also read all medication warning labels to be aware of possible side effects and must notify their health care provider (HCP) of job duties to allow the provider to determine if prescribed medications would interfere with the safe performance of the employee's job duties. Specific medication use guidelines for safety-sensitive employees are included in Policy HR 29:

- Safety-sensitive employees may not perform any safety-sensitive function if their medication carries a warning label that mental functioning, motor skills, or judgment may be adversely affected. In some cases, medications may be used only off-duty and with a time restriction from the last dose to permit sufficient elimination from the body.
- LA Metro provides a list of medications that do not pose a risk and thus are not required to be reported. All other medications must be reported on the Medication Reporting Form, which includes a required HCP signature to verify determination of fitness for duty.

- Safety-sensitive employees must submit a completed Medication Reporting Form any time they receive a new prescription for medication, to their manager, supervisor, or Workforce Well-Being Services (WWS) Representative. All forms are submitted to the WWS Representative for incorporation into the employee's central medical file.
- An employee who has not obtained an HCP signed authorization to consume medication with a warning label that indicates potential impairment may not perform safety-sensitive duties if this medication was taken within the past eight hours.
- If an HCP determines the employee cannot safely perform safety-sensitive functions while taking the prescribed medication, the employee must report that finding to their supervisor.
- The submission of a Medication Reporting Form does not exempt an employee from fitness for duty evaluation requirements.

There are also consequences defined in HR 29 for failure to comply, which include candidate disqualification, employee discipline up to and including termination for misstatements, concealments, and failure to submit a Medication Reporting Form.

Section 2.0 of LA Metro's HR 29 includes definitions of terms, and Section 3.0 defines responsibilities for employees and managers/supervisors. The policy concludes with a list of references, attachments, and procedure history.

LTD

LTD requires that medical examinations be performed for all safety-sensitive employees and public safety officers prior to establishing employment, including transfers from non-safety-sensitive positions. LTD may also require a fitness for duty examination if a medical issue occurred that could pose a safety risk prior to return to duty. LTD addresses the requirement for medical examinations for fitness for duty in the Collective Bargaining Agreement with the Amalgamated Transit Union (ATU) Local 757, in which Part 1, Article 8 details that the employer pays for all examinations required.

MARTA

MARTA requires operators and safety-sensitive employees to take bi-annual physical examinations conducted by a MARTA-designated physician to determine fitness for duty. Operators who have been off work for 90 days or more are required to complete a physical examination, including a drug and alcohol test by a physician designated by MARTA for the purposes of determining fitness to return to work. Additionally, MARTA may require any operator who was hospitalized to take a physical examination prior to return to duty according to Section 1.10 of its *Professional Bus Operator Pocket Manual*.

Maryland MTA

Maryland MTA's CDL Policy Section 9 requires that medical examination and certifications be performed and issued by an MTA-approved medical service provider. Applicants must qualify for an annual certification to be eligible for employment, which may be waived in specific cases. Section 12 of the policy describes medical waivers and exemptions criteria. Under no circumstances may an employee be permitted to work if they do not meet the necessary job requirements and qualifications, regardless of waivers or exemptions obtained.

Port Authority of Allegheny County

The Port Authority's Fitness for Duty Policy (rev. January 2018) applies to all employees and outlines an employee's responsibilities of reporting to work fit for duty. It requires that employees take medications responsibly and report medication use in accordance with the Port Authority's Medication Policy and establishes that if an employee is unfit for duty, they may not work. Further, it requires employees to report if they are unfit for duty or if they observe a co-worker that may not be fit for duty and provides that Port Authority employees who are in safety-sensitive positions must meet physical qualifications to retain a CDL, as determined by a fitness for duty medical examination performed by a valid Medical Examiner contracted through the Port Authority healthcare provider.

The Port Authority requires applicants and employees in maintenance positions who have insulin-dependent diabetes to obtain an exemption to operate a commercial motor vehicle pursuant to the Port Authority Insulin-Dependent Diabetes Exemption Program.

Managers and supervisors are responsible for observing employees they supervise, and if actions such as problems with dexterity, coordination, memory, alertness, vision, and speech are apparent, they are directed to make an appropriate response determination, including but not limited to calling police if an immediate threat exists, contacting the medical department for direction, referring the employee to the employee assistance program, or assigning retraining if appropriate.

The Port Authority requires a fitness for duty medical examination as part of:

- Pre-employment, as a condition of hire
- Before re-hire or reinstatement
- Transfer into a position with different physical requirements
- Before returning to duty after an injury or illness of eight days or longer, an injury or illness requiring hospitalization, or an injury or illness that suggests a serious safety risk
- If essential job functions may be impaired by a medical condition

- When advised by a public health official that an employee may pose a risk of spreading disease.

The Port Authority's Fitness for Duty Policy defines reasonable accommodation, confidentiality and records details, and a detailed list of injuries or illnesses that suggest serious safety risks, including but not limited to:

- Loss or impairment of limb that interferes with grasping or operating a commercial motor vehicle
- Diabetes
- Cardiovascular conditions, or heart condition known to be accompanied by fainting, shortness of breath, collapse, or congestive heart failure
- Respiratory dysfunction
- Hypertension
- Rheumatic, arthritic, orthopedic, muscular, neuromuscular, or vascular disease
- Any condition that is likely to cause a loss of consciousness
- Mental or psychological disorders
- Serious injury to eyes or ears
- Use of a prescription medication that is a controlled substance
- Alcoholism or drug addiction

Rio Metro

Rio Metro safety-sensitive employees are required to provide medical examination certification prior to employment and to renew their operator medical certification card. A physician's certificate is required prior to return to duty in the following circumstances:

- Employee has taken more than three consecutive days of sick leave
- Employee's work performance is inadequate
- Employee demonstrates an inability to maintain regular attendance
- Employee demonstrates a pattern of absences indicative of sick leave abuse or misuse; a pattern of absences consists of at least 3 occurrences in a rolling 12- month period.

SacRT

At SacRT, medical examination certification is required prior to employment, including fitness for duty in accordance with the physical demands of the employment classification. Physical examinations are administered by the Human Resources Recruitment Team, which is also responsible for retaining the records of the medical certifications. Renewal of the medical certification is required bi-annually for DOT commercial class operator renewal. Employees who are off work for more than three consecutive days may be required to

provide medical verification and clearance to return to duty. Employees are also tested for drug and alcohol use pre-employment randomly for reasonable suspicion, post-accident, and prior to returning to duty if off duty for 90 days.

SEPTA

As a part of SEPTA's Multi-Modal System Safety Program Plan, the Fitness for Duty Program defines specific medical and monitoring requirements in Section 19.1. SEPTA requires all modal safety-sensitive employees to conform to FMCSA requirements for commercial drivers as defined in Title 49 CFR 391.41, which defines a person as physically qualified to operate a commercial motor vehicle if that person:

- Has no loss of a foot, leg, hand, or arm likely to interfere with the ability to perform normal tasks associated with operating a motor vehicle
- Has no impairment of hand, finger, arm, foot, or leg likely to interfere with the ability to perform normal tasks associated with operating a motor vehicle
- Has no medical history or diagnosis of diabetes, cardiovascular disease, respiratory dysfunction, high blood pressure, rheumatic arthritic, orthopedic, muscular, neuromuscular, or vascular disease, or epilepsy, likely to interfere with the ability to perform normal tasks associated with operating a motor vehicle
- Has no mental or psychiatric disorder likely to interfere with the ability to perform normal tasks associated with operating a motor vehicle
- Has distant acuity of at least 20/40 in each eye, field of vision of at least 70° in the horizontal meridian in each eye, and the ability to recognize the colors of traffic signals
- Does not have average hearing loss in the better ear greater than 40 decibels at 500 Hz, 1,000 Hz and 2,000 Hz
- Has no current diagnosis of alcoholism

These physical qualification standards are examined pre-employment for all safety-sensitive employees and are also applied periodically to SEPTA railroad locomotive engineers and conductors and to law enforcement. Title 49 CFR 391.41 requires re-certification every two years for commercial operators; SEPTA does not conduct periodic examinations for other employees. Additionally, paratransit services are contracted through Customized Community Transportation (CCT), and those employees are not examined as part of SEPTA's Fitness for Duty Program.

Section 19.5 describes SEPTA's Over the Counter Medication reporting suggestions, although not required as reportable; SEPTA displays a comprehensive list of OTC medications at all work locations that employees should consider may induce drowsiness or the possibility of work restrictions.

This OTC reporting is separate from SEPTA's Drug Free Workplace Policy, which obligates all safety-sensitive employees to report their consumption of specified prescription medication to SEPTA Medical.

Section 19.6 covers stress through designation of the Employee Assistance Program (EAP), and Section 19.7 covers the medical monitoring programs in place at SEPTA, including monitoring programs for employees diagnosed with hypertension, diabetes, coronary artery disease, sleep disorders, and selected psychiatric disorders to ensure that the effects of the diagnoses do not interfere with an employee's ability to perform their duties as assigned.

TriMet

TriMet's Medical Examination Policy 4.6 requires that all TriMet employees be physically able to perform all essential functions of their positions, and medical examinations are required pre-employment for safety-sensitive positions and after returning to work from absence due to injury, illness, or serious health condition. TriMet requires medical examinations be performed by a TriMet-contracted medical physician, subject to limited exceptions, such as when reference to a specialist is necessary.

Oregon DOT mandates that all operators of commercial vehicles be able to pass a physical qualification examination, which includes contracted employees who operate a commercial vehicle in the state. The State of Oregon calls on the federal FMCSA physical qualifications listed in Title 49 CFR 391.41, with specific exemptions programs available for vision, hearing, seizure, and loss of limb criteria.[46]

TriMet's medical examination policy concludes with a list of circumstances that may require a safety-sensitive employee to undergo a medical examination, aside from pre-employment criteria, including:

- Return to duty after a leave of absence of 6 months or longer
- After experiencing a health problem that could jeopardize safety such as heart attack or stroke
- Symptoms suggest a health condition (diagnosed or undiagnosed) that could compromise safety
- Any circumstance where TriMet has reasonable belief that an employee's ability to perform essential job functions may be impaired by a medical condition.

[46] https://www.oregon.gov/odot/dmv/pages/driverid/cdlmedex.aspx.

HOS Agency Policies

Table 3-7 shows a comparison of HOS limitations included in the policies of the following 11 transit agencies:

- LA Metro
- LTD
- MARTA
- Maryland MTA
- Massachusetts Bay Transportation Authority (MBTA)
- NFTA
- Port Authority
- Rio Metro
- SacRT
- SEPTA
- TriMet
- Washington Metropolitan Area Transit Authority (WMATA)

Table 3-7 does not include all HOS policy content for these agencies, and it is important to understand that limits are subject to agency policy changes. Each policy limits the number of hours in a shift, ranging from 12 to 18 hours, and minimum hours off between shifts, ranging from 6 to 10 hours. Some items that vary by agency include maximum workdays per week, hours per week, or hours per month.

Table 3-7 *Transit Agency HOS Policy Elements*

Transit Agency	Maximum Drive/Work Hrs	Maximum Shift Hrs	Maximum Consecutive Hrs	Minimum Hours Off Between Shifts If Worked 12 Consecutive Hrs	Minimum Hours Off Between Shifts	Maximum Work Hrs in Two Consecutive Days	Maximum Overtime Hrs per Week	Maximum Work Hrs per Week	Maximum Work Hrs per Month	Maximum Consecutive Days of Work	Minimum Hrs Off per Service Day
LA Metro (light rail transit)	12	16	12		8						
LTD (bus)	12	14	14	9.5	9.5	28		98	392	13	9
MARTA (all employees)	16	16	16		8					7	8
MARTA (bus)	14	14	14		10					6	8
MBTA (bus & rail)	14	16			10		20				
MBTA (maintenance)		16			6		24	64			
MTA Maryland (safety-sensitive employees)	16	16	16	8	8						7
NFTA (all operators and maintenance)	10	14.98	14.98	8	8	29.96				15	8
Port Authority (bus)	18	18			8	30					
Rio Metro (bus)	10	15	15	8	8	30				8	8
SacRT (safety-sensitive employees)	10	15	12	8	8	30			320		
SEPTA (surface transit)	16	16	12	10	8	30					
SEPTA (rail)		12	18	10	8	30					
TriMet (rail)		16			9				310	13	7
TriMet (light rail vehicle mechanics and MOW)		17			9				310	13	
TriMet (bus)		17			9			70		13	7
WMATA (rail and bus)		14	12		10 *					6	

**24 hours if employee works 6 consecutive days*

LA Metro

In California, the CPUC governs safety-sensitive employees through Safety Regulations in General Order 143-B pertaining to licensing requirements; the prohibition of alcohol, narcotics, or drugs; and HOS limits. Specifically, CPUC GO 143-B limits LRT system safety-sensitive employees to remain on duty for no more than 12 consecutive hours or no more than an aggregate of 12 hours spread over a period of 16 hours.[47] LA Metro's Rail Rulebook outlines the operating rules and procedures related to HOS through General Order 143-B with more stringent limitations outlined in detail for their safety-sensitive employees:

- Daily bids may not exceed 11 hours 40 minutes within a 16-hour period and require a minimum of 8 hours off duty within each 24-hour period.
- On-duty time is limited to 12 consecutive hours or no more than 12 aggregate hours over 16 hours, with initial on-duty status beginning only after 8 consecutive hours off duty.
- After being on duty the maximum 12 operating hours, a minimum of 8 hours off is required within any one 24-hour period.
- Exceptions for HOS may be granted, not to exceed one additional hour, in the case of weather, emergencies, medical reasons, or disaster.

Any safety-sensitive employee who violates this rule must notify appropriate management immediately in writing with an explanation of circumstances upon completion of the assignment.

LTD

LTD details many elements of its fatigue risk management efforts in the labor contract between LTD and ATU Local 757 Part 1, Article 16, which details the hours of work limitations. LTD operators are required to have 9.5 hours off between shifts, at least 8 hours off for extra board operators, with shifts that extend no more than 1 hour and drive time that does not exceed 12 hours. Additionally, bus operators are limited to no more than 13 consecutive working days without a day off. Service limitations are able to be waived under emergency declarations but should remain in place to the maximum extent possible.

MARTA

MARTA instituted its Alertness Assurance Program in 2005 with the purpose of improving workplace safety by increasing awareness of the relationship between fatigue and accident/injury and establishing limits on maximum work time and minimum hours off duty. This program applies to all employees with

[47] https://www.cpuc.ca.gov/gos/GO%20143B.pdf.

a goal of reducing fatigue to increase alertness and vigilance to potentially improve safety through reduced fatigue-related accidents.

Specific work time limitations are extended to all MARTA employees and contracted employees:

- Work time is not permitted to exceed 16 consecutive hours.
- Work time is not permitted to exceed 16 hours in a 24-hour period.
- Minimum of 8 consecutive hours off duty is required within a 24-hour period.
- Minimum of 24 consecutive hours off duty is required after working for 7 consecutive days.

For MARTA bus operators, *Bus Operator Pocket Guide,* Section 1.13 states that every attempt will be made to ensure that an operator will have at least 10 consecutive hours off for rest every 24-hour period, and bus operators are restricted to working no more than 6 consecutive days, both of which are more stringent restrictions than the restrictions detailed in the alertness policy that is applied Authority wide.

MBTA

MBTA defines its limitations of work hours in its Rules for Operations Employees General Rule 21. HOS limitations vary by the employment position; General Rule 21A defines the limitations of work hours for transportation workers including operators and motor persons as follows:

- On-duty time is limited to no more than 14 hours in a 16-hour period, no matter the duty assigned; if an employee who operates a passenger vehicle also worked as a flagperson or inspector prior to operating the vehicle, all cumulative time on duty is included in the 14-hour maximum limitation.
- Minimum of 10 hours off is required before beginning the next day's work.
- On-duty time is limited to no more than 60 hours in a 7-day week beginning on Sunday and ending on Saturday.
- On-duty time is limited to no more than 40 hours in a 72-hour period.
- Bids and assignment swaps must not allow for less than 10 hours off duty between the end of one shift and the start of a new shift.
- Notification to the Desk Official of the acceptance of any work that would violate work hour limitations is required.
- No more than 20 hours of overtime are permitted per workweek for operators and motor persons.
- An employee must alert the OCC Dispatcher at least an hour in advance when HOS allowance will be exceeded.

This rule is subject to waiver in incidence of disaster or any unforeseen situation in which service is required to ensure public safety or to prevent unreasonable interruptions of service.

In addition to transportation workers, MBTA also includes limitations on work hours through general rules for engineering and maintenance personnel and rail and bus vehicle maintenance personnel. MBTA engineering and maintenance HOS limitations include:

- No more than 16 hours on duty in a 24-hour period
- Minimum of 6 hours off duty between shifts
- No more than 24 hours of overtime hours per week

MBTA rail and bus vehicle maintenance HOS limitations include:

- No more than 16 hours on duty in a 24-hour period
- Minimum of 8 hours off duty between shifts (except vehicle engineers, who are required a minimum of 6 hours off between shifts)
- No more than 24 hours of overtime hours per week

Port Authority

The Port Authority of Allegheny County, as regulated by Commonwealth of Pennsylvania Executive Order No. 017 A.D. 2013, requires that recordkeeping for the verification of hours worked be maintained for three years to ensure compliance with requirements and that fatigue awareness training programs for drivers and managers are in place and that individuals responsible for scheduling drivers take fatigue awareness strategies into consideration. Specific requirement limits outlined in PennDOT Order No. 017 include the following:

- Bus operators must not drive more than 18 hours per day.
- Bus operators must not be on duty more than 18 hours per day.
- Bus operators must have at least 8 consecutive hours off duty between shifts (excluding split shifts).
- Bus operators must not operate a bus more than 30 hours in two consecutive days.

HOS limitations can be waived in the case of emergency events, although notification of such waiver must go to the Bureau of Public Transportation and the Pennsylvania State Police by the close of the second business day following the emergency event.

Rio Metro

Rio Metro limits the number of consecutive hours on duty to 15 of 24 hours; if an operator is on duty for 12 or more hours in a 24-hour period, a log is required.

No operator can remain behind the wheel for more than 10 hours in a 24-hour period, with a minimum of 8 consecutive hours off between shifts. Rio Metro limits all operators to no more than 80 hours on duty in 8 consecutive days.

SacRT

SacRT calls on the FMCSA HOS limitations of 10 hours maximum drive time, 15 hours maximum on-duty time, and a minimum of 8 hours off duty between shifts.

SEPTA

Within SEPTA's Multi-Modal System Safety Program Plan (SSPP) 2018, Part 3 Section 19.2, HOS limitations are defined for each mode of transportation, including railroad, rail transit and bus, and CCT (paratransit). Specific HOS limitations for railroad are governed by 49 CFR Part 228, HOS Requirements which include the following:

- Train and engine personnel may work no more than 12 consecutive hours.
- Train and engine personnel must have at least 8 consecutive hours off duty and a minimum of 10 consecutive hours off duty if the employee worked a full 12 consecutive hours.
- If train and engine personnel work 13 of 14 consecutive days, that individual must not initiate any on-duty period for the next 2 consecutive days.
- Any train and engine personnel who work six consecutive days, with any one day including a Type 2 assignment, must have 24 hours off prior to returning to duty. (A Type 2 assignment is any assignment having time on duty before 4AM or after 8PM.)[48]
- Train dispatchers are limited to 9 hours on duty in a 24-hour period, which may exceed up to a maximum of 12 hours in emergency situations.
- Rail signal service personnel are limited to 12 hours on duty with a minimum of 10 undisturbed rest before returning to duty.

Rail transit and bus operators at SEPTA are governed by the Commonwealth of Pennsylvania Executive Order No. 017:

- Bus operators can remain on duty for no more than 16 hours with a mandatory 8 hours rest between shifts and no more than 30 hours on duty in a two-day period.
- Trolley and Norristown High Speed Line (NHSL) operators are equally limited to no more than 16 hours on duty with a mandatory 8 hours of rest

[48] https://www.federalregister.gov/documents/2011/08/12/2011-20290/hours-of-service-of-railroad-employees-substantive-regulations-for-train-employees-providing.

between shifts and no more than 30 hours on duty in a two-day period due to their status as CDL operators.

- Market Frankford Line (MFL) and Broad Street Line (BSL) operators can remain on duty for no more than 18 hours and no more than 30 hours in a two-day period.

Paratransit services are contracted services, and duty hour limitations are subject to the discretion of the individual contract carriers.

Section 19.3 is related to fatigue management, which describes the goals of periodic fatigue seminars and requires fatigue is included in new hire orientation. The goals of SEPTA's fatigue awareness seminars are to identify the symptoms and causes of fatigue, explore fatigue-related issues, and identify strategies to reduce fatigue.

There are additional guidance and procedures outlined in SEPTA's HOS Program, which is intended to provide personnel who operate bus, trolley, trackless trolley, and NHSL with an opportunity to obtain sufficient rest between daily work shifts and minimize the effects of fatigue on performance. The HOS Program does not apply to SEPTA's MFL, BSL, and Commuter Railroad regulated by FRA. The program outlines the same general requirements listed, with additional details related to required recordkeeping, specific responsibilities, compliance auditing, and procedures for extreme circumstances.

SEPTA's HOS Program details the training and sleep disorder assessment and treatment requirements for fatigue awareness management. Through the program, fatigue awareness training must include at a minimum:

- Symptoms of fatigue
- Physiological and human factors that affect fatigue
- Strategies to reduce or mitigate the effects of fatigue
- Alertness strategies
- Effects of abrupt changes in rest cycles

As part of the Sleep Disorder Assessment, all new employees in safety-sensitive classifications must complete a Berlin Questionnaire for sleep apnea, and any candidates that rank as "high risk" must complete a sleep study. SEPTA physicians also must physically examine each prospective operator candidate for risk factors that could disrupt the individual's sleep.

TriMet

Rail operations at TriMet are governed by the state safety oversight of rail fixed guideway public transportation systems as defined in Oregon Administrative Rule (OAR) 741-060-0010 through 741-060-0110, which applies to all rail fixed guideway public transportation systems in Oregon that are not subject to FRA

regulations. OAR 741-060-0100 requires RTAs develop an HOS policy for safety-sensitive employees.

TriMet established an HOS Policy in compliance with OAR 471-060-100, with the purpose of assuring that operations and maintenance of TriMet revenue vehicles are not put at risk due to safety-sensitive employee fatigue, which applies to the following job classifications:

- Bus operator
- Light rail operator
- Bus maintenance journeyman mechanic
- Light rail vehicle maintenance technician
- Road operations dispatcher
- Road supervisor
- Rail supervisor
- Light rail operations controller
- Light rail signals maintenance technician

HOS limitations as delineated in the policy include:

- Minimum of 7 consecutive hours off duty in 24 hours
- No more than 70 hours worked in a 7-day period
- No more than 13 consecutive days worked

Changes in HOS standards for bus operators occurred in February 2013, with minimum hours off duty extended to 9 hours for operators who work the extra board and 10 hours for operators who do not. Changes in HOS standards for rail maintenance went into effect in June 2015 to increase the minimum time off duty from 7 hours to 9 hours and limits employees to 310 hours of safety-sensitive work in a calendar month.

WMATA

WMATA implemented Policy 10.7/1, Hours of Service Limitations for Prevention of Fatigue with the purpose of mitigating the risk of fatigue impacting employees who perform safety-critical functions. The policy outlines definitions and responsibilities by department, in addition to defining specific limitations by department. Transportation and bus maintenance employees, including rail and bus operators, are limited to:

- No more than 14 hours on duty, including interim release periods
- No more than 12 consecutive hours on duty
- Minimum of 10 consecutive hours off duty
- No more than 6 consecutive days on duty

WMATA management is also encouraged to minimize night work, to the extent possible, to prevent work during circadian lows. Bus Operations Control Center and Rail Operations Control Center employees are limited to:

- No more than 12 hours on duty
- Minimum of 12 consecutive hours off duty between shifts
- No more than 6 consecutive days on duty

WMATA Policy 10.7/1 also addresses HOS limitations for other safety-sensitive employees such as transit infrastructure and engineering services and the Metro Police Department. Additionally, the policy details enforcement protocol and emergency exceptions to the policy.

WMATA has also implemented a Fatigue Risk Management Policy (10.6) to prevent and mitigate fatigue and promote alertness and vigilance. This policy applies to all employees and includes definitions and defines responsibilities of all stakeholders. Section 5.00, Policies and Procedures ensures that all employees are trained on fatigue risk management and encourage employees to take advantage of opportunities to sleep in addition to reinforcing the HOS restrictions outlined in Policy 10.7. Policy 10.6 is currently under revision, including an anticipated updated focus on fatigue declaration and reporting. Draft language of the policy revisions encourage employees to self-identify fatigue to be afforded relief in accordance with departmental policy.

Section 4

Gap Analysis

The limited availability of national transit safety event causal and contributing factor related data restricts understanding the impact of fatigue and medical fitness for duty risk factors in the industry. The research team was tasked with identifying the gaps in existing voluntary standards, guidance documents, or other tools and strategies to inform the transit industry; however, the most significant "gap" identified in this exercise was the limitation that exists with current transit safety data reporting.

Given the recognition that fatigue and medical fitness for duty are factors specifically recognized within the transportation industry and identified in accident NTSB investigation reports, the need for guidance in the transit industry is evident. As such, the research team examined federal standards, state regulations and legislation, other industry recommended practices and guidance documents, and various NTSB recommendations to determine specific fatigue and medical fitness for duty-related topics that could benefit from future guidance development.

Analysis of fatigue risk management within FTA's SMS Framework resulted in Figure 4-1, which shows some key medical fitness for duty and fatigue-related elements that may be addressed in an agency's SMS safety management policy, safety risk management, safety assurance, and safety promotion functions.

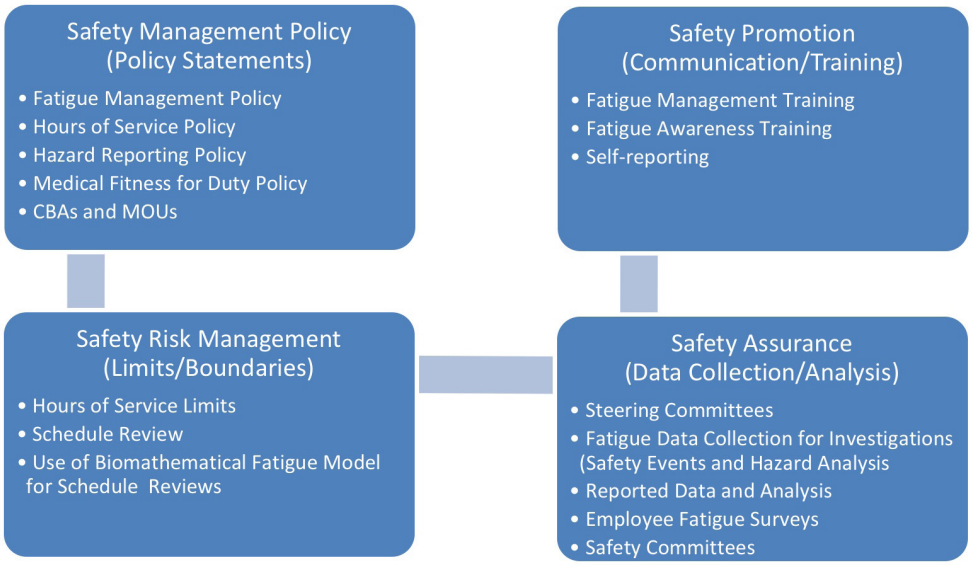


Figure 4-1 *Fatigue Risk Management Elements of SMS Framework*
Source: CUTR

Section 5

Summary of Findings

Catastrophic events may be avoided if a transit operator, maintenance technician, dispatcher, or other transit employee responds timely and effectively to safety-critical tasks occurring during routine daily operations. A transit employee who is not medically fit for duty or is fatigued may be unable to effectively perform these safety-critical tasks and, therefore, may jeopardize their own safety or that of other transit personnel, riders, or the traveling public.

The research objectives for this report included the following:

- Perform background research and analysis on needs for new standards, recommended practices, guidance documents, or procedural considerations in the areas of medical fitness for duty and fatigue risk management.
- Identify gaps that may exist in standards, recommended practices, or guidance documents available to the industry to address medical fitness for duty and fatigue risk management.
- Present findings to FTA for its consideration related to the development or issuance of voluntary standards, protocols, guidelines, recommended practices, or additional research related to medical fitness for duty and fatigue risk management.

Based on the research conducted in accordance with the objectives above, the following findings are presented for consideration as ways medical fitness for duty and consequently transit safety can be improved significantly by implementing best practices and policies. Robust employee safety reporting programs encourage employees to report fatigue and fitness for duty related concerns. Requiring pre-employment and return to duty medical examination certification for all safety-sensitive employees may reduce reportable incidents. Testing for sleep disorders and associated practices may reduce the potential risk factors associated with driving while fatigued. Hours of service policies that define the limits for driving time, time on duty, time off duty between shifts, maximum work week hours, maximum number of consecutive workdays, and emergency service provisions to reduce or mitigate fatigue risk may reduce the number of transit safety events.

- **Finding 1 – Data Limitations:** The National Transit Database (NTD) is the reporting platform for FTA transit agency grantees. NTD's Safety and Security Major-Only Time Series dataset, which is reported on the Safety and Security (S&S) 40 form, does not identify causal or contributing factors to major transit events. Therefore, there is no aggregated national transit data that can account for injury and fatality events that may have been due to or influenced by fatigue or due to illnesses or conditions associated

with medical fitness for duty. The limited availability of national transit safety causal and contributing factor related NTD data restricts the ability to understand the full impact of fatigue and medical fitness for duty risk factors in the industry.

- **Finding 2 – Employee Safety Reporting**: Robust and mature employee safety reporting programs encourage employees to report fatigue and fitness for duty concerns and are essential for safe transit operations. Transit Cooperative Research Program (TCRP) Report 81, "Toolbox for Transit Operator Fatigue," documents the principles, techniques, and strategies used in the development of fatigue mitigation plans, which includes providing employees with an opportunity to report their own fatigue without fear of discipline or retribution. Additionally, Federal Railroad Administration (FRA) Safety Advisory 2004-04 recommends that railroads implement policies to promote self-reporting of sleep-related medical conditions, with the intent of reducing risk associated with fatigue and fitness for duty.
- **Finding 3 – Fitness for Duty Testing Requirement**: Requiring pre-employment and return to duty medical examination certification for all safety-sensitive employees may reduce reportable incidents. The importance of establishing pre-employment fitness for duty medical examinations is evident through comparison of the medical examination requirements for the 10 public transit agency policies included in this report, all of which require pre-employment fitness for duty medical examinations for all safety-sensitive employees.
- **Finding 4 – Fitness for Duty Applicability**: Consistent definitions of minimum employment duty criteria that are classified as safety-sensitive may reduce variability in qualification criteria and reduce incidents. FTA defines safety-sensitive duty criteria for drug and alcohol testing requirements in 49 CFR 655 for a safety-sensitive function as any of the following duties when performed by employees of recipients, subrecipients, operators, or contractors: operating a revenue service vehicle, operating a non-revenue service vehicle, controlling dispatch or movement of a revenue service vehicle, maintaining a revenue service vehicle or equipment used in revenue service, or carrying a firearm for security purposes. Expanding safety-sensitive definition criteria applicability consistently for all safety-sensitive guidance would reduce the current variation permitted throughout the transit industry.
- **Finding 5 – Fitness for Duty Qualification Limits**: At least eight states in the US have instituted minimum medical examination requirements in statewide statutes or administrative codes, some of which adopt federal regulations by reference, such as the Federal Motor Carrier Safety Administration (FMCSA) regulated 49 CFR 391.41-391.49. Additionally, the American Public Transportation Association (APTA) Standard for Rail

Transit Fitness for Duty Program Requirements assigns transit authorities the responsibility of identifying the minimum medical requirements related to the job responsibilities of their safety-sensitive employees due to the unique operating characteristics of public transit agencies. However, there are key commonalities in recommended fitness for duty testing for safety-sensitive employees, including sleep disorder screening, testing, and treatment. Verification of explicitly defined minimum medical fitness for duty qualification criteria for employment, through medical examination performed by a certified medical examiner, may reduce incidents and improve overall system safety.

- **Finding 6 – Fatigue Risk Management**: The National Highway Traffic Safety Administration (NHTSA) recognizes people with untreated sleep disorders, shift workers, and public safety personnel as higher-risk populations for fatigued driving. NTSB's 2019–2020 Most Wanted List of Transportation Safety Improvements included a suggestion that the transit industry collaborate to develop a model national labor agreement that supports effective programs for addressing sleep disorders and other medical conditions among safety-sensitive personnel. Testing for sleep disorders and associated practices may reduce the potential risk factors associated with driving while fatigued.
- **Finding 7 – Fatigue Risk Management Policies**: The requirement of extensive documentation of occasional and infrequent absences encourages employees to report to work when ill, increasing the likelihood of errors. Non-punitive attendance policies that also account for absenteeism require a delicate balance, as there are challenges associated with ensuring that employees are available when needed. Lax attendance policies can lead to increased patterns of absenteeism, which ultimately can impact budgets and lead to delays in service and other organizational inefficiencies. However, effective attendance policies that also include procedures that encourage employees to self-report fatigue that may impair their ability to perform their duties may reduce the number of fatigue-related incidents or close calls. The development of non-punitive attendance policies and procedures that encourage self-reported fatigue may reduce the number of fatigue-related incidents or close calls.
- **Finding 8 – Hours of Service**: In total, 10 of 50 states have established a minimum HOS regulation, and CFR 49 395.5 establishes HOS limitations for passenger-carrying operators who require a Commercial Driver's License (CDL). There are variations between states, with maximum driving time of 10–13 hours and minimum time off of 8–10 hours. HOS policies that define the limits for driving time, time on duty, time off duty between shifts, maximum work week hours, maximum number of consecutive workdays, and emergency service provisions to reduce or mitigate fatigue risk may reduce the number of transit safety events.

- **Finding 9 – Scheduling:** Long driving hours have the potential to cause fatigue, a contributing factor in collision events. Bus operator driving hours were found to influence the occurrence of preventable collisions in an analysis of collision occurrences in relation to operator schedules, with a discernible pattern of an increased propensity for collision involvement with increased driving hours. Additionally, split shifts with splits that exceeded two hours were correlated with a higher crash risk in another previous study. The consideration and mitigation of impacting factors of fatigue in the design of transit worker scheduling and transit route scheduling may reduce the potential for fatigue-related safety events and improve operator ability to perform their duties as assigned.
- **Finding 10 – Schedule Manager Certification**: Development of a formal work schedule manager certification program to ensure that all managers have the required expertise to properly create schedules taking employee health, safety, and performance into account may improve the safety of the industry through a reduction in fatigue-related safety events. NTSB recognized this need in 2015 in a recommendation to FTA for the identification of necessary training and certification needs for work schedulers in the rail transit industry and further recommending that FTA require transit agencies to provide training/certification for work schedulers.
- **Finding 11 – Biomathematical Modeling**: Biomathematical modeling is a tool recognized as beneficial for providing schedule outputs that take many complex interactions of fatigue-characteristics into consideration. These models can be a powerful method for visualizing non-intuitive relationships between variables such as patterns of work, sleep-wake behavior, and fatigue. With the understanding that no model or tool alone can accurately capture all risk, biomathematical models can predict fatigue based on characteristic inputs such as time of day, sleep history, workload, and length of shifts.

Appendix A

Literature Review

This literature review discusses medical fitness for duty, including the recommended elements of medical examinations, practices, and examination frequencies. It also focuses on testing specifically for sleep disorders and recognition and reporting of sleep disorders. Standards or practices associated with medical fitness for duty or those that frame fitness for duty programs include pre-selection qualifications for physical and medical fitness for duty in addition to routine medical fitness for duty examinations, self-reporting requirements, identified triggering events that require out-of-frequency fitness for duty testing, training and awareness, and defined roles and responsibilities of all stakeholders.[49] These elements and standards and recommended practices are discussed below.

Medical Fitness for Duty

Ensuring employee medical fitness for duty is critical for the safe operation and maintenance of transit vehicles. Employees who operate or have the potential to operate a vehicle in revenue service, including supervisors or controllers and other employees with safety-sensitive responsibilities, must be capable of performing their assigned duties.[50] To ensure medical fitness for duty capabilities, transit agencies may implement fitness for duty programs that delineate medical examination certification or other compliance requirements. The transit industry is not the only industry to identify the importance of fitness for duty; Chevron Corporation defines medical fitness for duty as a state of overall physiological and psychosocial health that enables an employee to perform their job without posing risk to themselves, others, and the environment.[51]

Fitness for duty testing uses an individual's performance to determine if they are mentally and physically fit to perform their assigned job duties.[52] This fitness for duty testing is critical in public transit operations due to the human performance necessary to operate and maintain a transit vehicle safely. "An individual with sufficiently degraded sensory, cognitive, or motor processes, regardless of the cause, may be deemed unfit for duty."[53] Fitness for duty was found to be a statistically significant variable in parameter estimates of collision and non-collision event models in an analysis of TriMet events that occurred in 2008 in Portland, Oregon.

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[49] https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-RT-S-OP-018-12-Rev-1-Fitness-for-Duty.pdf.
[50] https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-RT-S-OP-018-12-Rev-1-Fitness-for-Duty.pdf.
[51] DOI: 10.5327/Z16794435201816S1005 http://www.rbmt.org.br/details/333/en-US/fitness-for-duty-evaluations--what-s-in-health-and-medical-s-black-bag-.
[52] https://journals.sagepub.com/doi/pdf/10.1177/154193129604001201.
[53] *Ibid.*

Medical Examinations – Elements, Practices, Frequency

When considering the elements, practices, and frequency of medical fitness for duty examinations, many related components must work together to reduce fatigue-related events. To ensure a comprehensive approach, NTSB recommends that operators/industry develop formal sleep apnea programs that include screening, diagnosis, treatment, and follow up procedures.[54] Additionally, NTSB recommends that the medical examination be administered by a registered, certified, and qualified medical professional to ensure intended certification results that allow the successful identification of risk factors, evaluation, and treatment of OSA.[55] A comprehensive list of NTSB recommendations related to fatigue and medical fitness for duty are included in Appendix C.

TRACS Report 14-02, "Establishing a Fatigue Management Program for the Bus and Rail Transit Industry," included medical fitness for duty evaluations and screenings. The SMS-based approach to fitness for duty evaluations and screenings is shown in Table A-1.

Table A-1 *Medical Fitness for Duty through Safety Management Systems*

SMS Structural Element	Medical Fitness for Duty Evaluations and Screenings
Safety Policies and Procedures	Develop policies and procedures related to screening employees for sleep disorders and providing support for those employees.
Safety Risk Management	Risk of fatigue-related incidents can be reduced by screening employees for sleep disorders and requiring treatment.
Safety Assurance	Require employees identified as at-risk for sleep disorders to provide proof of screening and completion of treatment.
Safety Promotion	Establish trust that diagnosis of sleep disorders will not result in termination, provided adequate treatment is maintained, through a focus on safety culture improvement and supporting policies.

Source: TRACS Report 14-02, "Establishing a Fatigue Management Program for the Bus and Rail Transit Industry"

TRACS recognized the importance of policies and procedures requiring screening for sleep disorders and support to those diagnosed to be instituted to ensure that risk management can occur through required treatment of diagnosed sleep disorders, safety assurance occurs through the documentation of treatment completion, and safety promotion is possible through gained trust and improved safety cultures. Within such policies, the medical history elements that should be inquired about and the minimum physical characteristics that should be examined must be defined.

[54] https://www.ntsb.gov/safety/mwl/Pages/mwlfs-19-20/mwl8-fsh.aspx.
[55] *Ibid.*

Per APTA-RT-S-OP-018-12 Rev-1, APTA Standard for Rail Transit Fitness for Duty Program Requirements, transit authorities are responsible for identifying the minimum medical requirements related to the job responsibilities of safety-sensitive employees because each transit authority has unique operating characteristics. However, there are key commonalities in all recommendations of fitness for duty testing for safety-sensitive employees, which is the inclusion of sleep disorder screening, testing, and treatment. Typically, screening occurs through both medical history questioning and a physical examination to identify risk factors that may be signs of sleep disorders.

Some state DOTs, such as Florida, have enacted statewide medical examination standards. Chapter 14-90, Florida Administrative Code (FAC) provides equipment and operational safety standards for public bus transit systems in Florida. Section 14-90.0041, Medical Examinations for Bus Transit System Drivers, delineates the medical examination requirements for all applicants for driver positions and existing drivers. It establishes the process for performing the evaluations and qualifications of performing physicians or other Medical Examiners and establishes the frequency for testing and return to duty requirements. A Medical Examination Report form (FDOT Form 725-030-11) is adopted by reference and includes a health history section to be completed by the bus transit system driver (Figure A-1) and physician entries associated with testing results. The final section provides certification status, including period of qualification and any disqualifying conditions, and Medical Examiner signature. The Medical Examination Certificate for Bus Transit System Driver is shown in Figure A-2.[56]

In addition, drivers are required to list all medications they take.[57] The Medical Examiner is then responsible for determining medical qualification for employment in terms of vision, hearing, and blood pressure. A urinalysis is required to determine blood sugar levels to rule out diabetic conditions. Each of these medical conditions is not necessarily cause for exclusion of employment eligibility but may require more frequent medical examination certification to ensure that the medical condition is treated adequately to reduce risk. Similarly, FMCSA may grant exemptions if the proper procedures are followed to achieve an acceptable level of safety compliance. For example, FMCSA currently has exemption programs for vision and insulin-treated diabetes mellitus and offers a program for drivers with missing or impaired limbs.[58]

The coordination and continuous updating of a Medical Examiner National Registry provides an opportunity to ensure that Medical Examiners understand

[56] https://www.flrules.org/gateway/ruleNo.asp?id=14-90.0041.
[57] https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/transit/pages/amendedmedicalexaminationreport.pdf?sfvrsn=13a415fd_0.
[58] https://www.fmcsa.dot.gov/faq/it-possible-get-exemptions-some-medical-conditions.

medical standards and how they apply to commercial motor vehicle drivers. A Medical Examiner National Registry also allows for competency of examiners to be maintained through the use of training, testing, and certification, which will promote public confidence in the quality of medical examinations and also ensure accessibility of listed certified Medical Examiners.[59]

CDL medical driver qualification requirements through Federal Motor Carrier Safety Regulations (FMCSRs), included in 49 CFR Part 391, apply only to drivers of commercial motor vehicles that operate in interstate commerce; however, many states also call on this requirement for intrastate CDL medical requirements of drivers of commercial motor vehicles.[60] Regarding recertification, FMCSRs do not require an examination upon return to duty from injury or illness unless the operator's ability to perform normal duties was impaired, although medical qualification recertification is permitted if the employer chooses. FMCSA's Medical Review Board has recommended OSA screening, although this has not yet been adopted into regulation.

[59] A. Guzik, "The Federal Motor Carrier Safety Administration's National Registry of Certified Medical Examiners and Medical Certification of Interstate Commercial Motor Vehicle Drivers," *Workplace Health and Safety*, 61(11) (2013): 495-502.
[60] National Academies of Sciences, Engineering, and Medicine, *Application of Physical Ability Testing to Current Workforce of Transit Employees* (Washington, DC: The National Academies Press). https://doi.org/10.17226/14446.

Rule 14-90.0041, F.A.C.

FLORIDA DEPARTMENT OF TRANSPORTATION
MEDICAL EXAMINATION REPORT FOR BUS TRANSIT SYSTEM DRIVER

725-030-11
Transit
05/09

1. DRIVER'S INFORMATION Driver completes this section.

Driver's Name (Last, First, Middle)	Birthdate / / MM/DD/YY	Age	Sex ☐ M ☐ F	☐ Preemployment ☐ Biennial ☐ Follow Up ☐ Return to Duty	Date of Exam / /

Address	City, State, Zip Code	Work Tel: ( ) - Home Tel: ( ) -	Driver License No. License Class ☐ A ☐ B ☐ C ☐ D ☐ Other	Date Issued / /

2. HEALTH HISTORY Driver completes this section indicating any below described illness, medical condition, or injury that currently exists or has occurred. The medical examiner is encouraged to discuss with driver.

YES	NO		YES	NO		YES	NO	
☐	☐	Head/Brain injuries, disorders or illness	☐	☐	Muscular disease	☐	☐	Loss of, or altered consciousness
☐	☐	Seizures, epilepsy	☐	☐	Shortness of breath	☐	☐	Fainting, dizziness
		☐ medication _____	☐	☐	Lung disease, emphysema, asthma, chronic bronchitis	☐	☐	Sleep disorders, pauses in breathing while asleep, daytime sleepiness, loud snoring
☐	☐	Eye disorders or impaired vision (except corrective lenses)	☐	☐	Kidney disease, dialysis	☐	☐	Stoke or paralysis
☐	☐	Ear disorders, loss of hearing or balance	☐	☐	Liver disease	☐	☐	Missing or impaired hand, arm, foot, leg, finger, toe
☐	☐	Heart disease or heart attack; other cardiovascular condition	☐	☐	Digestive problems	☐	☐	Spinal injury or disease
		☐ medication _____	☐	☐	Diabetes or elevated blood sugar controlled by:	☐	☐	Chronic low back pain
☐	☐	Heart surgery (valve replacement/by pass, angioplasty, pacemaker)			☐ diet	☐	☐	Regular, frequent alcohol use
☐	☐	High blood pressure			☐ pills	☐	☐	Narcotic or habit forming drug use
		☐ medication _____			☐ insulin	☐	☐	Any illness or injury not described by this section
			☐	☐	Nervous or psychiatric disorders, e.g., severe depression			
					☐ medication _____			

For any **YES** answer, indicate onset date, diagnosis, treating physician's name and address, and any current limitation. List all medications (including over-the counter medications) used regularly or recently.

_____

_____

_____

I certify that the above information is complete and true. I understand that inaccurate, false or missing information may invalidate the examination and qualification by the Medical Examiner.

_____ Driver's Signature

_____ / / Date

Medical Examiners Comments on Health History (The medical examiner must review and discuss with the driver any "yes" answers and potential hazards of medications, including over-the-counter medications, while driving.)

Figure A-1 *FDOT Medical Examination Health History components*

MEDICAL EXAMINATION CERTIFICATE

for Bus Transit System Driver

I certify that I have examined_____ in accordance with the requirements in Rule 14-90.0041, Florida Administrative Code, and referenced FDOT Form 725-030-11, and with knowledge of driving duties, I find that this person:

Note certification status here and on the medical examination form.	If applicable, only when:
☐ MEETS STANDARDS (RE-EXAMINE IN 2 YEARS)	☐ Corrective Lenses
☐ DOES NOT MEET STANDARDS	☐ Wearing hearing aid
☐ MEETS STANDARDS, BUT PERIODIC EVALUATION REQUIRED	☐ Temporarily disqualified due to:
DRIVER IS QUALIFIED ONLY FOR:	
☐ 3-MONTHS ☐ 6-MONTHS ☐ 1 YEAR ☐ OTHER	
Return to medical examiner's office for follow-up on _____	

The information I have provided regarding this physical examination is true and complete. A complete examination form with any attachments embodies my findings completely and correctly, and is on file in my office.

Medical Examiner's Signature:	Telephone:	Date:
Medical Examiner's Name: (Print)	Medical Examiner's License or certificate number	
	Issuing State:	
	☐ MD ☐ DO ☐ Physician Assistant ☐ Advanced Registered Nurse Practitioner	
Office Address: (Print)		
CITY COUNTY STATE ZIP		
Name of Driver: (Print)	Driver License No.	Issuing State:
Signature of Driver:		Date:

Figure A-2 *FDOT Medical Examination Certificate*

The rail industry has also not yet adopted regulations requiring OSA screening of employees in safety-sensitive positions, and NTSB recognizes the risk associated with undiagnosed and untreated OSA in the rail industry.[61]

Testing for Sleep Disorders and Associated Practices

NTSB's 2019–2020 Most Wanted List of Transportation Safety Improvements recognizes that "the absence of regulations in the railroad industry focused on screening for, diagnosing, and ensuring adequate OSA treatment means that employers may be unaware of their employees' impairing medical conditions or medication use."[62]

In the TRACS 14-02 report, fitness for duty screening considerations were limited solely to screening for sleep disorders, at a minimum OSA, due to their prevalence in the general population and among transportation workers and

[61] https://www.ntsb.gov/safety/mwl/Pages/mwlfs-19-20/mwl8-fsr.aspx.
[62] *Ibid.*

the disrupting affects that can lead fatigue and degraded performance.[63] An FRA 2005 report, "Medical Standards for Railroad Workers," revealed that over 60% of the US railroad workers are ages 45–64 and more than 90% are male. Additionally, a higher percentage of males experience sleep apnea, and the prevalence of sleep apnea, along with the prevalence of other sleep disorders, increases with age.[64] Even through the recognized risk and susceptibility, sleep disorders are not addressed in any regulatory modal standards; voluntary guidance is provided through FMCSA Advisory Criteria, FAA's Guide to Aviation Medical Examiners, and the USCG Vessel and Navigation Information Circular 02-98.[65]

Recognition and Reporting of Sleep Disorders

FRA's "Medical Standards for Railroads" suggests that failure to recognize potentially incapacitating medical conditions can have serious safety consequences for railroad employees and the public.[66] Even within the general population, unrecognized sleep-disordered breathing is linked to and may account for as significant portion of motor vehicle collisions.[67]

Medical fitness for duty can also be impacted by temporary circumstances or illnesses that may not be present when a safety-sensitive employee is examined for medical fitness for duty. These temporary illnesses, such as the common cold, have side effects that may make sleeping and/or breathing more difficult, leading to the use of OTC medication, which may negatively affect medical fitness for duty by causing drowsiness and/or decreasing reaction times.[68]

With the prevalence of sleep disorders indicated in NTSB investigation reports (detailed in Appendix C), the Board recommends that the effects of fatigue on performance by safety-sensitive employees be considered in all aspects of an organization, including training and guidance, policy and procedural designs, schedule development, fitness for duty determinations, collision investigations, and audits or compliance reviews to manage risk due to fatigue in a holistic and preventive manner.

Fitness for duty-related NTSB recommendations to various industry stakeholders revolve around requiring safety-sensitive employees to divulge all diagnosed disorders; developing and implementing OSA identification programs and guidance for employees who are diagnosed with sleep disorders; developing and implementing policies, procedures, and audit processes to

[63] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/TRACS_Fatigue_Report_14-02_Final_(2).pdf.
[64] Federal Railroad Administration, "Medical Standards for Railroad Workers," January 2005.
[65] *Ibid.*
[66] *Ibid.*
[67] T. Young et al., "Sleep-disordered Breathing and Motor Vehicle Accidents in a Population-Based Sample of Employed Adults," *Sleep* 20, no.8 (1997): 608-13.
[68] NTSB Railroad Accident Brief 18/06, SEPTA Trolley Collision, January 4, 2017.

ensure that all safety-sensitive employees are fit for duty; and requiring medical fitness for duty examinations be performed by approved and certified Medical Examiners. NTSB also has recommended that safety-sensitive personnel who have been diagnosed with chronic conditions be required to submit to more frequent medical certification examinations. Additional medical fitness for duty recommendations include determining what constitutes a valid and reliable field test for color discrimination capabilities for employees in safety-sensitive positions and requiring the use of that field test once it has been deemed valid and reliable.

The recognition and treatment of OSA and other sleep disorders are imperative in the reduction of sleep-related risk because treatment with continuous positive airway pressure (CPAP) with good adherence can normalize the risk for collisions and can improve the amount and quality of sleep, quality of life, and overall health of the treated individual.[69]

Fatigue Risk Management

This section of the literature review defines fatigue and the dangers associated with performing safety-sensitive duties while fatigued and includes a summary of fatigue countermeasures within and outside of the transportation industry; a review of OSA; HOS impacts on fatigue risk; transit worker scheduling; and transit route scheduling. The section concludes with a review of literature regarding training to recognize signs and symptoms of fatigue impairment, fatigue-related distractions, and the use of biomathematical models and other tools to reduce fatigue-related risk.

Fatigue

Fatigue is not just feeling very tired; an all-inclusive definition of fatigue should include a subjective experience, a physiological condition, a performance decrement, and a dynamic multidimensional concept to determine a whole definition, which could be used no matter the context of fatigue.[70]

In 1999, Aaronson et al. defined fatigue as "awareness of a decreased capacity for physical and/or mental activity due to imbalance in the availability, use, and/or restoration of resources needed to perform an activity." Hirshkowitz defined fatigue as a physiological condition of weakness due to repeated exertion or a "decreased response of cells, tissues, or organs after excessive stimulation, stress, or activity."[71] Fatigue as a performance decrement is defined as "the effects of tiredness on metabolic activity within the prefrontal parietal cortices

[69] "Sleep Apnea and Its Role in Transportation Safety" (2017), doi: 10.12688/f1000research.12599.1.
[70] R. O. Phillips. "A Review of Definitions of Fatigue – And a Step Towards a Whole Definition," *Transportation Research Part F: Traffic Psychology and Behaviour, 29 (2015): 48-56.*
[71] https://www.sleep.theclinics.com/article/S1556-407X(13)00031-3/abstract.

having consequences for a wide range of cognitive functions, mainly via effects on the prefrontal cortex."[72] Craig et al. used a multidimensional concept to define fatigue as a "psychophysiological state that occurs when a person is driving and feeling tired or drowsy, to the extent that they have reduced capacity to function, resulting in performance decrements and negative emotions and boredom as they attempt to stay awake during the task."[73]

A whole definition of fatigue was established in 2015 as a suboptimal psychophysiological condition caused by exertion, with the degree of fatigue dependent on the form, dynamics, and context of exertion that results in changes in strategies or resource use such that original levels of mental processing and/or physical activity is reduced.[74]

Fatigue may be one of two types—sleep-related or task-related—both of which can diminish driving performance and increase crash risk.[75] To better understand the different types of fatigue, it is necessary to examine the outcomes of sleep-related fatigue and task-related fatigue (Figure A-3).

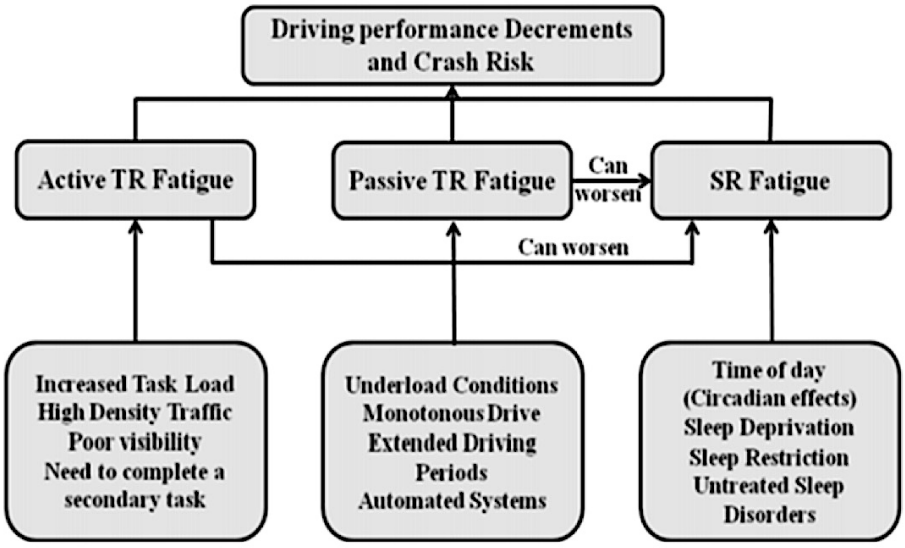

Figure A-3 *Sleep-related vs. task-related fatigue outcomes*

Source: May and Baldwin, 2009

[72] W. D. Killgore, "Effects of Sleep Deprivation on Cognition," *Progress in Brain Research*, 185 (2010): 105–29.

[73] https://researchers.mq.edu.au/en/publications/psychophysiological-characteristics-of-driver-fatigue.

[74] Phillips, *op. cit.*

[75] https://www.sciencedirect.com/science/article/pii/S1369847808001009?via%3Dihub.

Sleep-related fatigue may be due to one of two sleep factors that regulate the human body—sleep homeostasis and circadian rhythm factors. Sleep homeostasis is defined as a prolonged period of wakefulness that is directly followed by a prolonged period of sleep.[76] Sleep homeostasis is described as the human body's need for sleep, which increases in a linear fashion starting directly after waking (Philips, 2015). In other words, the longer one is awake, the more tired they will feel as the day progresses, until ultimately one succumbs to sleep. Sleep homeostasis is a daily cycle and is independent of the time one typically wakes or sleeps.

Circadian factors are daily oscillations in human biological rhythms that have been found to effect human efficiency of execution of tasks (Valdez et al., 2012). Circadian rhythms are found in most bodily functions such as temperature, nervous system activity, and sleep cycles and refer to a single daily cycle. Other rhythmic cycles include ultradian—more than one cycle per day—and infradian—less than one daily cycle. Circadian rhythms vary among people but typically produce oscillations in performance every 24 hours, unlike homeostatic cycles, which are a gradual decay in performance over time awake. Studies have shown that performance and alertness as measured by reaction times correlate with body temperature, which is on a circadian rhythm, with performance increasing with body temperature until the approximate midday peak, after which performance and alertness begin to decay and fatigue begins to increase.[77] The same part of the brain that controls circadian rhythm, the hypothalamus, is also impacted by outside factors such as darkness, which signals a time for tiredness. That darkness signal to the hypothalamus causes a release of melatonin, which makes the body feel tired. Circadian rhythms change as a person ages.[78]

Driver fatigue does not always stem from a lack of sleep, as task-related fatigue, known as active fatigue, is able to interfere with an operator's ability to operate a vehicle even in the absence of any sleep-related cause. Active fatigue is caused by an increase in task load, such as high-density traffic, poor visibility, or the need to complete other duties as assigned.[79] Task-related fatigue may be classified as either active or passive. The time duration necessary for a task to lead to fatigue will vary depending on what type of factor is causing the fatigue. For instance, it is more likely that a person will experience the feeling of fatigue quicker when doing a strenuous activity, such as exercising, as opposed to a boring or monotonous activity, such as counting coins. Put into a driving

[76] https://www.ncbi.nlm.nih.gov/pubmed/23746394.
[77] https://www.ncbi.nlm.nih.gov/pubmed/12388468.
[78] https://www.sleepfoundation.org/articles/what-circadian-rhythm.
[79] J. F. May, and C. L. Baldwin, "Driver Fatigue: The Importance of Identifying Causal Factors of Fatigue when Considering Detection and Countermeasure Technologies," *Transportation Research Part F*, 12 (2009): 218-224.

context, a transit driver who is required to multitask on a high passenger volume route with accompanying high traffic volumes would generally feel fatigued faster than a transit driver who drives a low passenger volume route with little to no traffic. In addition to the time it takes to feel fatigued, these different factors leading to fatigue cause different types of fatigue. Active fatigue is due to exertion from cognitive overload or high-demand performance over time, such as driving in dense traffic while adhering to a timed schedule, collecting fares, and communicating with dispatch simultaneously. Passive fatigue is due to exertion from under-load or low-demand conditions such as driving for long periods of time with little traffic flow and little variation in environment, where cruise control can allow for passive behavior while driving (Philips, 2015).

There are several possible contributors to fatigue, such as voluntary or directed attention, lifestyle factors, medical conditions, and psychological conditions. In 2010, Kaplan and Berman published research describing how directed attention depends on executive functioning and self-regulation.[80] In their research, executive functioning is defined as managing of oneself and one's resources to achieve a goal,[81] whereas self-regulation is defined as the capacity to behave oneself and resist temptation, which are functions relying on a common resource.[82] Self-regulation and executive functioning draw on the same resources—those within the human body, which are finite in amount and able to be depleted. The depletion of these bodily resources will cause fatigue and thus impact one's performance.[83]

It is also necessary to distinguish the differences of voluntary and involuntary attention. Involuntary attention requires no effort and is typically exciting or interesting to the observer.[84] Some examples of objects or activities that may instigate involuntary attention include strange or unfamiliar shapes, especially moving objects that are not immediately recognized, such as an unfamiliar wild animal grazing on the side of the road. Shiny or metallic objects are also known to be causes of involuntary attention, in addition to undesirable sights such as vehicular collisions. Although these sources of involuntary attention may cause distraction, they do not typically contribute to fatigue.

Directed or voluntary attention is different from involuntary attention in that it is attention that requires effort, is not tied to stimulus, and is not an automatic response.[85] Voluntary attention is an intentional focus that requires effort and may lead to fatigue over time. Directed attention is the attention most

[80] https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1341247.
[81] http://www.ldonline.org/article/29122/.
[82] https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1341247
[83] *Ibid.*
[84] *Ibid.*
[85] *Ibid.*

needed to operate a transit vehicle, with sporadic moments of involuntary attention throughout the driver's shift. Not only is a transit operator required to constantly use their directed attention to perform their responsibilities while on duty, but the amount of directed attention needed to perform these required tasks is more strenuous than simply driving a personal vehicle for the same amount of time. For example, a transit bus operator is expected to not only drive the bus along the route while following a schedule and overcoming congestion on the route, they are also responsible for collecting passenger fares, giving passengers directions and connecting route schedules when needed, recording trip information using logbooks, and communicating with dispatch to report delays, problems, disputes, or difficulties.

Fatigue is also referred to as a feeling of burnout; in this context, it is referred to as job burnout, a prolonged response to chronic emotional and interpersonal stressors on the job, primarily from exhaustion, cynicism, and inefficacy.[86] The research suggests that common strategies known to reduce burnout are vigor, physical strength, and good health. Vigor refers to high energy, effortful completion of work-related duties, the lack of fatigue, and persistence to face difficulties.[87] Burnout is a serious problem that must be addressed, especially in the public transit sector, because it is known to lead to reduced productivity and job satisfaction and increased absenteeism and employee turnover.[88]

The Governors' Highway Safety Association reported that over 5,000 people died in highway crashes where drowsy driving was noted as a contributor.[89] Meanwhile, a February 2020 fact sheet released by the Royal Society for the Prevention of Accidents, a United Kingdom (UK) charitable organization, reported that driver fatigue may be a contributing factor in up to 20% of highway accidents and in up to 25% of fatal and serious accidents. Fatigue-related crashes are reported as resulting in an increased likelihood (50%) to result in death or serious injury.[90] They discuss sleep disorder factors and report that those individuals are 6–15 times more likely to have an accident than those without the condition. Additionally, there is recognition that the statistics related to drowsy driving are underreported.

NHTSA produced the 5th edition of the *Model Minimum Uniform Crash Criteria (MMUCC) Guideline* in 2017 that outlines some of the challenges associated with the use of collision data. There is a lack of data uniformity, in terms of both definitions and collection methods, that hinders the ability to

[86] https://www.annualreviews.org/doi/abs/10.1146/annurev.psych.52.1.397.
[87] *Ibid.*
[88] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3456620/; https://www.scribd.com/document/330645373/Bus-Driver-Well-being-Review-50-Years-of-1.
[89] https://www.ghsa.org/issues/drowsy-driving.
[90] https://www.rospa.com/media/documents/road-safety/driver-fatigue-factsheet.pdf

make collision data comparisons between localities, states, or nationally.[91] Additionally, MMUCC guidelines suggest that a collision investigation defines a driver as "asleep or fatigued" if the "driver experienced a temporary loss of consciousness, was drowsy or asleep, or was operating in a reduced physical or mental capacity due to weariness, medication, or other drugs."[92] This fatigue attribute is highly underreported due to the inability to determine post-collision if an involved party is not available or willing to offer the information. This lack of ability to make national data comparison, coupled with a lack of consistent fatigue detection factors, makes total fatigue-related crash impacts largely under-quantified.

National Cooperative Highway Research Program (NCHRP) Report 715, "Highway Safety Manual Training Materials," provides training content to aid in implementing AASHTO's *Highway Safety Manual* (HSM).[93] It includes content related to human factors that should be included in the diagnosis performed to identify contributing collision factors through a safety management process. NCHRP Report 600, "Human Factors Guidelines for Road Systems," suggests that design equations for the HSM be based around an impaired or fatigued driver rather than a typical driver, given their higher collision risk, because fatigue can affect the psychological processes that underlie perception-reaction time plus maneuver time.[94]

As noted, fatigue is defined as a suboptimal psychophysiological condition caused by exertion, such that original levels of mental processing and/or physical activity are reduced.[95] Fatigue can be categorized as active or passive, and many factors have the potential to contribute to levels of fatigue in individuals.

Fatigue Countermeasures

In "Countermeasures for Use in Fatigue Risk Management," the researchers performed a literature review to identify and explain 15 fatigue countermeasure types, which they grouped along what they termed a "fatigue risk trajectory."[96] The trajectory begins when work causes fatigue. If the operator fails to recover from this fatigue, symptoms may manifest, leading to fatigue-related errors, and ultimately, if left unchecked, will also lead to fatigue-related incidents. Effective fatigue risk management monitors and controls the risk along the entire trajectory, using effective countermeasures. Fifteen countermeasures were identified to assist transportation managers in identifying the combination of methods most beneficial for their situation based on their level of risk:

[91] NHTSA, Model Minimum Uniform Crash Criteria, 5th Edition (2017). https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812433,
[92] *Ibid.*
[93] http://www.trb.org/Publications/Blurbs/167185.aspx.
[94] http://www.trb.org/Main/Blurbs/167909.aspx.
[95] Phillips, *op. cit.*
[96] https://www.toi.no/getfile.php?mmfileid=43284.

1. Adequate manning – increase the number of operators.
2. Schedule design – optimized schedules should be based on biomathematical modeling with input data on actual sleep times.
3. Breaks and naps – plan and evaluate strategic napping interventions, if appropriate.
4. Actual hours worked – compare and analyze the variation in the actual work hours versus the planned schedule.
5. Optimize work content – reduce secondary tasks that cause fatigue.
6. Monitor actual sleep – wearable devices that provide personalized feedback and tips on sleep improvement could also provide valuable data for schedule design.
7. Health screening and treatment – develop a checklist to be used at regular check-ups to ensure fatigue-related illnesses are effectively treated.
8. Promote operator recovery – provide sleeping facilities at depots.
9. Monitor fitness for duty – vigilance test results could be fed into an FRMS.
10. Monitor fatigue symptoms while operating – embedded performance monitoring, facial/eye movement technology.
11. Contain fatigue while operating – promote stopping and sleeping.
12. Performance assistance technology – this countermeasure requires further validation.
13. Fatigue-proofing – increase customer awareness and involvement, and implement technological safeguards.
14. Continuous learning – provide safety assurance through data driven evaluations of each risk level at regular meetings.
15. Other organizational measures – safety culture development through a needs analysis.

It is important to note that not all countermeasures are possible in all types of transportation services. For instance, it would not be plausible to promote stopping and sleeping to contain fatigue if a person is operating a city bus in revenue service.

TCRP Report 81, "Toolbox for Transit Operator Fatigue," documents the principles, techniques, and strategies used in the development of fatigue mitigation plans.[97] The report includes a compilation of various tools available to assist transit agencies in the intervention of risk associated with operator fatigue. Each tool identified in the report, along with the intended function of the tool, is presented in Table A-2 by type of intervention opportunity.

[97] http://www.trb.org/Publications/Blurbs/153765.aspx

TRB's Transit Innovations Deserving Exploratory Analysis (IDEA) 80, "Enhancing Safety and Security of Transit Systems Using Computer Vision," fostered the development of a driver facial monitoring system prototype that was then tested on buses at SEPTA and the Metropolitan Transportation Authority (MTA) of New York City to validate the system and determine sensitivities.[98] Testing protocols were established to test the accuracy of the computer vision prototype to accurately monitor and track a variety of facial features, including glasses, different skin tones, and facial hair, at different levels of illumination and various degrees of facial movement. The prototype was upgraded in phases as various challenges were identified. When lighting and camera positioning were revealed as challenges for camera detection, the prototype was upgraded with a new infrared (IR) camera and moved to a new position on the bus, and the software was upgraded. When working properly, the prototype camera was able to accurately recognize when fatigue was detected in an operator through blinking frequency. Head positioning, glasses, and hat placement were all found to be challenges when considering the field of view of the camera even after the upgrades; thus, the subsequent accuracy and ability to detect signs of fatigue will depend upon proper camera placement and policies and procedures to ensure that the camera field of view is not purposefully or accidentally obstructed.

In TCRP Report 169, "Developing Best-Practice Guidelines for Improving Bus Operator Health and Retention," researchers addressed some of the health and safety issues common throughout the transit industry and described approaches that transit organizations in the US and Canada have taken to address health problems faced by transit employees.[99] The report includes a *Practitioner's Guide (Part I)* and an Evaluation and Return on Investment (ROI) template titled "Transit Operator Workplace Health Protection and Promotion Planning, Evaluation, and ROI" (available online) for use in implementing and carrying out transit-specific programs to protect the health of bus operators and other employees. The final research report (Part II) includes background, research approach, literature review, case examples, and detailed case studies. The guide, template, and report are intended for use by senior managers, operations managers, organized labor, safety officials, medical personnel, risk managers, human resources personnel, policymakers, and legal advisors.

[98] http://www.trb.org/Main/Blurbs/176774.aspx.
[99] https://www.nap.edu/download/22322.

Table A-2 *Fatigue Risk Management Tools Available from TCRP Report 81, "Toolbox for Operator Fatigue"*

Intervention Opportunity	Tool	Function
1. Managing personal habits and behaviors	Sleep Debt Index	Assess overall level of sleep debt and resulting sleepiness
	Personal Alertness Manager	Analyze and improve personal work/sleep patterns
	Personal Alertness Predictor	Predict on-duty alertness
	Use and Abuse of Caffeine	Determine appropriate use of caffeine and sources of caffeine
	Drugs and Alertness	Understand drugs that affect alertness
	Strategic Napping	Determine when to nap
	Exercise Basics	Understand relationship between exercise, fatigue, and sleep
	Break Time Stretches	Stretching exercises to improve circulation and loosen tight areas after extended period of sitting
	Tips for Healthy Sleep	Guidelines for fostering restorative sleep
	Making Your Family Part of Your Fatigue Management Strategy	Suggestions on family's role in managing fatigue
	Do I Have a Sleep Disorder?	Self-evaluation for potential sleep disorders
	Run Selector	Process and guidance on selecting runs
	Adjusting to Shiftwork	Guidance on how to adapt to shiftwork
2. Reporting for duty and managing service delivery	Fatigue Hotline	Resource for answering fatigue-related questions
	Fatigued Employee Process for Supervisors	Guidance on managing fatigued employees
	Rest Breaks	Importance of rest breaks in maintaining alertness
	Work Variety	Strategy for reducing boredom and enhancing alertness
3. Analyzing and creating runs	Procedures for Developing Fatigue-Resistant Schedules	Ways to design schedules to minimize operator fatigue
	Alternatives to Long Spreads and Split Shifts	Ways to meet peak demands without fatiguing the operator
4. Assigning personnel to cover temporary vacancies	Guidelines for Filling Temporary Vacancies	Ways to make schedule changes without fatiguing the operator
	Managing the Extra Board	Provide work schedule predictability to the operator
	Special Events	Minimize potentially fatiguing work assignments

Table A-2 (cont.) *Fatigue Risk Management Tools Available from TCRP Report 81, "Toolbox for Operator Fatigue"*

Intervention Opportunity	Tool	Function
5. Designing facilities and equipment	Napping/Quiet Facility	Provide on-property facility for rest and napping
	Exercise Equipment	Provide facilities for exercise during breaks
	Vending Equipment	Provide healthy snacks that stimulate alertness
6. Recruiting and hiring new operators	The Lifestyle of a Transit Operator: Is it for You?	Set realistic expectations for operator candidates regarding hours of work
	Medical Examination	Screen for sleep disorders
	New Hire Training	Provide fatigue basics as part of new hire training
7. Investigating accidents	Fatigue Investigation Procedure	Determine if fatigue is a factor in accidents and incidents

TRB's Conference Proceedings on the Web 7, "Research on Fatigue in Transit Operations," provides a summary of TRB's Conference on Research on Fatigue in Transit Operations from 2011.[100] Speakers highlighted experiences addressing fatigue in other transportation modes and fatigue issues and initiatives in transit. Union Pacific (UP) representatives presented on the challenges associated with managing fatigue risk with geographically-dispersed employees, many of whom drive long distances to get to their location of duty. The Fatigue Risk Management System (FRMS) at UP uses policy, training, and education to identify, measure, and prioritize risk and implementation controls. UP uses a software package called the UP Board Game to program work and rest cycles and call windows for shift employees using a comprehensive and integrated process that considers historical data and current needs. UP also focuses on educational efforts ensuring that employees understand the minimum sleep requirements and fatigue hazard identification and self-management. Finally, UP representatives presented on the importance of identifying fatigue as a cause of errors or incidents to understand the true extent of fatigue-related risk. Representatives from Greyhound provided details about the Alertness Management Program (AMP), which was instituted in 2003 to reduce fatigue-related risks and included components of education, scheduling policies and practices analysis, and sleep and performance examinations. Greyhound representatives touted success in the AMP as demonstrated through subjective and objective data that demonstrated reduced fatigue-related risk.

[100] https://www.nap.edu/download/22705#.

Other presentations from the conference covered the safety implications of transit operator schedule policies, one of which questioned the adequacy of the minimum eight-hour rest time mandated through FMCSA given the necessity to travel to and from work in addition to eating, sleeping, and accomplishing other responsibilities while off duty.[101] The presenter shared findings from an analysis of six Florida transit agency schedules and collision data, which identified an overrepresentation in collisions occurrences for operators that operate the bus more than 60 hours per week. The overrepresentation ratio increased from 2.8 to 24.4 when driving 55–65 hours per week to over 65 hours for schedules with split shifts.[102] Metro Transit, serving the Minneapolis–St. Paul metropolitan area, introduced a two-part training to fight fatigue issues, first to identify and address fatigue and second to identify fatigue-related characteristics that may be present in the investigation of accidents.

Strategic Highway Research Program Report S2-RO3-RW-1, "Identifying and Reducing Workforce Fatigue in Rapid Renewal Projects," presents results of a three-year research project and associated results.[103] The research scope involved studying factors associated with workforce fatigue and stress in the rapid renewal environment and the risks to worker safety and construction productivity. The study team developed an integrated fatigue management toolkit, including work scheduling and work practice guidance based on fatigue models, organizational practice guidance, fatigue management reference material, and training materials for managers and workers. Practice guidance was based on a combination of countermeasures at the individual level and organizational practices to reduce fatigue-related risk both preventively and throughout operation. Some fatigue countermeasures in the guidance include the following:

- Engage in defensive napping in the afternoon prior to beginning a night shift.
- Sleep in when not working to make up for sleep loss accumulated throughout the work week.
- Use caffeine and strategic napping.
- Promote self-selected rest breaks.
- Use supervisory monitoring of signs and symptoms of fatigue.

These guidance materials were prepared with the goal of integrating applicable components into existing SMSs for highway projects, thereby reducing fatigue risk and increasing safety. Understanding how to recognize fatigued and the countermeasures available to combat feelings of fatigue may reduce the risk of fatigue-related incidents within any industry.

[101] https://www.nap.edu/download/22705#.
[102] *Ibid.*
[103] https://www.fdot.gov/docs/default-source/transit/pages/TransitOperatorSchedulePolicies.pdf.

This section describes many of the various countermeasures that are available in the transit industry and other modes of transportation to reduce fatigue and fatigue-related collision events. Specifically, if sleep disorders such as OSA are present, then implementing specifically-targeted countermeasures to reduce fatigue risk, such as CPAP treatment, can be especially successful. However, to successfully treat sleep disorders such as OSA, warning signs must be recognized and diagnosed.

Obstructive Sleep Apnea

In "Impaired Vigilance and Increased Accident Rate in Public Transport Operators is Associated with Sleep Disorders," researchers from the Center for Sleep and Vigilance Disorders at the University of Gothenburg, Sweden, investigated the prevalence of sleep disorders among public transport operators and assessed interventions in those diagnosed with OSA.[104] Their conclusions indicated that public transport operators had a high prevalence of sleep disorders, particularly OSA, which demonstrated a higher prevalence of work-related accidents. Their findings included recognition that the elimination of OSA led to significant improvements in daytime function and established that there is a need for greater awareness of sleep disorders and associated impacts.

In TRACS Report 14-02, "Establishing a Fatigue Management Program for the Bus and Rail Transit Industry," the complex issues associated with transit operator fatigue were highlighted, and challenges that may be faced in addressing transit employee fatigue were identified.[105] The report revealed that fatigue is a cause or contributor to about one third of all bus and rail transit accidents, indicating that fatigue is related to operator performance. A specific recommendation was made that "transit agencies provide mandatory fatigue awareness training and mandate medical health screenings at intervals of no more than one year for all safety-sensitive personnel and collect and track fatigue performance measures." The report also concluded that transit worker fatigue remains a serious problem for the whole industry, requiring an SMS approach to preventing fatigue-related incidents.

FRA and FMCSA have studied OSA and its role as a factor in rail and motor carrier incidents. In March 2016, FRA issued an ANPRM on OSA and requested data and information related to the prevalence of moderate-to-severe OSA and the potential consequences of this disorder on rail and highway safety.[106] (*Note*: This ANPRM was withdrawn in March 2018, but joint efforts between FMCSA and FRA are still underway to address the issue.) Although the ANPRM did not address a specific operational or personnel standard related to the topic (nor the efficacy of a given standard or protocol), it did provide several examples of railroad and highway accidents for which NTSB investigations were conducted.

[104] https://www.sciencedirect.com/science/article/pii/S0001457512004058.
[105] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/TRACS_Fatigue_Report_14-02_Final_(2).pdf.
[106] https://www.govinfo.gov/content/pkg/FR-2016-03-10/pdf/2016-05396.pdf.

In the examples provided, NTSB determined that OSA played a role in causing an accident (or near-accident) involving motor carriers and trains. These examples illustrate the risks associated with moderate-to-severe OSA. In 2017, NTSB stated that "obstructive sleep apnea has been the probable cause of 10 highway and rail accidents investigated by the NTSB in the past 17 years."[107]

Additional process applications can be drawn from FAA. Under new guidance issued in 2015, Aviation Medical Examiner screening processes for pilots include the opportunity to require further evaluations to determine is OSA is a risk factor for an individual.

"Investigating the Possible Contribution of Fatigue to Pipeline Mishaps," a white paper published in June 2011, studied if there is a reasonable probability that fatigue was a probable cause or contributing factor in a pipeline or hazardous material mishap.[108] Initial screening questions and methods to investigate the possible role of fatigue are provided and suggested to be used when operators (including shift leaders, controllers, analysis, and other associated with a mishap) worked:

- In the evening or overnight
- A rotating shift where hours change regularly
- A split shift
- Extended duty hours (more than 12 hours)
- Outside normal daylight hours
- A permanent evening or night shift

If an operator meets any of the above criteria, initial screening questions are suggested to determine the operator's 72-hour sleep history, if the event occurred due to a circadian or homeostatic low, and if inattention may have contributed to the mishap. The key to this mishap investigation is to establish two factors to determine that fatigue contributed to the event:

- The operator was susceptible to fatigue effects because of circadian or homeostatic sleep cycle lows, sleep disturbances, or medical issues.
- The operator's performance/behavior was consistent with the effects of fatigue at the time of the mishap.

If both criteria are met in an event investigation, then concluding findings should indicate a reasonable probability that fatigue was a probable cause or contributing factor, which should be documented to ensure that holistic incident investigations can reveal trends and lead to organization-wide reduction in fatigue-related risk.[109]

[107] https://www.ntsb.gov/news/press-releases/Pages/MR20180206.aspx.

[108] Miller, "Investigating the Possible Contribution of Fatigue to Pipeline Mishaps." Pipeline and Hazardous Materials Safety Administration (PHMSA) (2011).

[109] *Ibid.*

OSA can impair vigilance and contribute to increased collision rates; thus, it is important to be diagnosed when present, especially for safety-sensitive employees. OSA should also be considered in incident investigation to ensure that probable cause is properly diagnosed.

HOS

As noted, sleep/wake homeostasis and the circadian biological clock are the two processes that control sleep and wake periods in the human body.[110] With sleep/wake homeostasis, the longer the human body is awake, the greater is the need for sleep. The circadian biological clock, on the other hand, causes oscillating highs and lows of wakefulness throughout the day. Understanding these two factors on the human internal clock is integral in the comprehension of the relationship between HOS and fatigue.

Many industries have imposed HOS limits to reduce the risk associated with employee fatigue, as detailed in previous tables and chapters that describe the federal and state working limits. FRA published the *HOS Compliance Manual for Freight Operations* in December 2013 and the *HOS Compliance Manual for Passenger Operations* in May 2014 with the purpose of providing clarification on HOS requirements found in Title 49 CFR Part 228 to ensure standardized application and compliance.[111] These compliance manuals provide insight into how HOS directly impacts fatigue risk levels through an analysis of thresholds in two different biomathematical models that were calibrated and validated by FRA (FAST and FAID). Furthermore, fatigue mitigation plans should supplement minimum time off and maximum time on-duty limits established by Title 49 CFR Part 228. Noting the impossibility of eliminating fatigue completely, the development and implementation of fatigue mitigation plans are suggested to minimize fatigue-related risk through the consideration of severity and probability.[112]

As stated by Gertler et al. (2013), sleep is a function of work schedules including work duration, time of day of work, and schedule variability, which all determine when sleep can occur.[113] Furthermore, the amount and time of day of sleep account for up to 96% of fatigue exposure, fatigue exposure increases the risk of a human factors related accident occurring, and the economic cost is approximately quadrupled when compared to accidents that are not fatigue-related. Improving the predictability of schedules and educating workers about fatigue and sleep disorders are two of the suggestions to reduce railroad worker fatigue.[114]

[110] Johns Hopkins University (2020), https://www.hopkinsmedicine.org/health/conditions-and-diseases/sleepwake-cycles.
[111] https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/18866/2013-12_Hours_of_Service_Freight.pdf; https://railroads.dot.gov/elibrary/hours-service-compliance-manual-freight-operations.
[112] *Ibid.*
[113] Gertler, DiFiore, and Raslear, "Fatigue Status of the US. Railroad Industry," Federal Railroad Administration (2013).
[114] *Ibid.*

A Pipeline and Hazardous Materials Safety Administration (PHMSA) white paper, "Staffing of Regular, Cyclic 24/7 Operations," recognizes the additional challenges associated with reducing fatigue-related risk within non-stop operations, providing guidelines to optimal employment ratios, with the caveat that HOS limits must be implemented to assure an opportunity to obtain eight hours of continuous sleep between consecutive shifts.[115] An employment ratio makes allowances for holidays, sick leave, annual leave, training, and other administrative time required, which is calculated by summing the assumed annual values for each type of day and dividing by the total number of work days. This will always result in a ratio that is greater than 1. The employment ratio is then multiplied by the number of workers per crew and the number of necessary crews to calculate the optimal number of employees that should be scheduled.

The first federal regulations that governed the limitations for maximum flight time, maximum on-duty time, and minimum rest time for flight crews were written for the Civil Aviation Authority (CAA) in 1937 and changed by FAA in 1985 and 1995.[116] The airline industry has been considering the effects of irregular work hours and circadian disruption, which are inevitably characteristics of commercial pilot schedules, since at least 1984.[117] HOS research to determine and minimize acceptable levels of fatigue risk in the transportation industry has led to regulations across several modes. In 2009, FAA contracted with the National Aeronautics and Space Administration (NASA) to have an independent baseline assessment of fatigue in the air traffic controller workforce to shape the FRMS.[118] Many of the findings and subsequent mitigation actions were related to HOS and hours of sleep that effect fatigue. In 2011, FAA used model predictions compared against a fatigue threshold to provide guidance on acceptable duty schedules in the "Flightcrew Member Duty and Rest Requirements,"[119] which was based on the SAFTE model.[120]

FAA has a robust fatigue awareness and mitigation program that includes flight time limitations, time on duty, and minimum rest time for safety-sensitive employees to ensure enough rest is provided to reduce the likelihood of fatigue impairment.[121] This was discussed previously in this report.

[115] Miller, "Staffing of Regular, Cyclic 24/7 Operations," PHMSA White Paper (2011). https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/technical-resources/pipeline/control-room-management/68996/staffingregularcyclic247operationswhitepaperfinal110617.pdf.
[116] Rosekind, "Managing Fatigue in Operational Settings 2: An Integrated Approach," *Behavioral Medicine*, 21(4) (1996): 166-170, DOI: 10.1080/08964289.1996.9933754.
[117] https://doi.org/10.1080/0014013031000085653.
[118] https://www.faa.gov/data_research/research/media/NASA_Controller_Fatigue_Assessment_Report.pdf.
[119] https://www.federalregister.gov/documents/2014/12/09/2014-28868/flightcrew-member-duty-and-rest-requirements.
[120] Rangan and Van Dongen, "Quantifying Fatigue Risk in Model Based Fatigue Risk Management," *Aviation Space Environ Med*, 84 (2013): 155.
[121] Realistic Scheduling Agreement: Defining Principles and Objectives, https://www.sciencedirect.com/science/article/pii/S2352146519305976?via%3Dihub.

The Rail Transit Safety Action Plan of 2006 investigated 550 collisions, derailments, and fires between 2002 and 2004 for FTA's State Safety Oversight Program, which revealed that 52 of 437 light rail collisions (12%) and 5 of 36 (14%) heavy rail collisions were caused by operator fatigue and inattentiveness.[122]

NTSB has also determined that overtime work schedules without considering and mitigating worker risk of fatigue contributed to the fatal collision in 2017 between an MTA Long Island Railroad (LIRR) train and a railway worker. Investigations revealed that the watchmen and foreman had consecutive overtime shifts that disrupted their opportunities for restorative sleep during the 48 hours prior to the collision. NTSB further determined that without an FRA requirement of HOS regulations, roadway workers are at risk for fatigue-related accidents involving the movement of trains. Specifically, the recommendation was to "promulgate scientifically-based HOS requirements for roadway workers (R 20-7)."[123]

HOS determines the time available for an employee to rest, as fatigue is influenced by both sleep/wake homeostasis (increased wakefulness leads to increased need for sleep) and a person's circadian biological clock (oscillating highs and lows of wakefulness). HOS studies have led to various regulations in many transportation modes that limit the time on duty and ensure adequate time off duty between scheduled shifts.

Transit Worker Scheduling

Long driving hours have a potential to cause fatigue, a contributing factor in collision events. "Safety Implications of Transit Operator Schedule Policies" examined the influence of bus operator driving hours on the occurrence of preventable collisions by employing data from a questionnaire survey, incident reports, and operator schedules to evaluate the correlation between driving hours, amount of sleep, and operator involvement in collisions.[124] Results of the analysis of collision occurrences in relation to operator schedule showed a discernible pattern of an increased propensity of collision involvement with an increase in driving hours, with 53% of truck drivers with the highest rates of working hours (at least 48 hours/week) attributing sleepiness to near-miss events, and 7.5% attributing sleepiness to an accident.[125] Based on the fatigue analysis, drivers involved in collisions were found to be overrepresented in the red fatigue condition, i.e., fatigue scores higher than the fatigue tolerance level.

[122] https://www.hsdl.org/?view&did=774672.
[123] https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR2001.pdf.
[124] Hoang, "Safety Implications of Transit Operator Schedule Policies." *UNF Graduate Theses and Dissertations*, 628 (2016), https://digitalcommons.unf.edu/etd/628.
[125] *Ibid.*

In 2004, US DOT released "Optimizing Staffing Levels and Schedules for Railroad Dispatching Centers," which concluded that staffing levels at dispatch centers appeared to be more of the product of management judgement than rigorous analysis.[126] A work schedule of three fixed shifts with a relief crew has been typical for US railroad dispatching operations for over 75 years. One disadvantage of the three fixed-shift schedule is the need for extra board dispatchers to fill in for occasions when the regularly-scheduled dispatcher cannot work. This report revealed that in any given week, as many as 25% of the shifts required the use of extra board dispatchers. The researchers stated that extra board dispatchers are inherently subject to random and potentially fatiguing work schedules due to variations in the schedules. They further stated that the possible addition of working nights could also limit an individual's ability to socialize with family and friends. Noting the effect that lowered social well-being can have on fatigue, the researchers found that there are a few promising options for both reducing employee fatigue and easing the job of the scheduler in filling vacancies. These include a three crew self-relieving system, fixed shifts with variable days off, targeted use of relief and extra board dispatchers, and 12-hour weekend shifts. A three-crew self-relieving system assigns optimal staff to cover the days that dispatchers are not available by increasing the number of people working fixed shifts by a shift relief factor, which can potentially remove the need for rotating extra board dispatcher shifts.

Similarly, in 2008, Ku et al. studied how organizational factors affect the job-related factors related to fatigue, health, and social well-being. A 148-item questionnaire was given to locomotive engineers and conductors, the results of which were analyzed to show any patterns or relationships between the different analyzed factors.[127] Of interest for scheduling were the length of working hours, variety, predictability, discipline, and rest window. The research showed that social well-being is a factor that directly affects fatigue, social well-being may be a mediator between work scheduling and fatigue, and work scheduling/sleep are not the only fatigue factors, as was thought to be the case.

In 2010, FRA's Office of Research and Development released a report studying the gap in scheduling knowledge between scheduling managers and current research. The results of the study suggested that the most significant gaps are related to addressing the demands of shift work. Shift work schedulers' key responsibilities should include monitoring performance and safety to determine whether there are shift-related safety risks.[128] The report revealed the need for additional training for scheduling managers to ensure that they understand the impact work schedules have on employee health, safety, and performance and take this into consideration when schedules are made. With

[126] US DOT, "Optimizing Staffing Levels and Schedules for Railroad Dispatching Centers" (2004).
[127] Ku and Smith, "Organizational Factors and Scheduling in Locomotive Engineers and Conductors" (2010).
[128] US DOT, "Work Schedule Manager Gap Analysis" (2010).

a lack of standardized training on impacting factors of fatigue, information is taught through short-term mentorship, which provides the opportunity for bad habits and bad schedule designs to propagate. The FRA study recommends that a formal work schedule manager certification program be developed to ensure that all managers have the required expertise to properly create schedules taking employee health, safety, and performance into account. A similar certification program instituted for the transit industry could reduce fatigue-related risk through informed schedule development that is improved through the consideration of employee health, safety, and performance.

Service hours of four fixed-route transit agencies in Florida were analyzed to determine the strength of the relationship between fatigue and preventable collisions in "Modeling Fatigue-Induced Collision Relative Risk: Implications of Service Hours and Fatigue Management Policies on Transit Bus Operators in Florida," a report published in 2013.[129] The analysis also considered the effects of driving time and/or split-shift scheduling, where operators are required to split their work day into more than one time segment in the day. The analysis evaluated collision data for 2007–2009, which included 222 collisions, and other associated variables including start time, hours on task, off-duty hours, and schedule type. Results of the analysis revealed that collision risk increased as driving time increased and off-duty time decreased. Additionally, circadian rhythm impacts were also apparent in the data analysis, as collision risk increased for shifts beginning from 3:00–6:59 AM (the window of circadian low that is known to occur from 2:00–6:00 AM for individuals adapted to usual day-wake/sleep-night schedules).[130] Furthermore, operators who worked split-shift schedules also had longer working days, earlier start times, and later end times, which the authors suggested leads to potential increases in operator fatigue.[131]

Working from the results that were discovered in the 2013 report,[132] Hoang found that split shifts with splits that exceeded two hours were correlated with a higher crash risk, whereas split shifts that had splits of less than two hours were not.[133] Accident proportions relative to driving time proportions are four times greater when split times are 2–3 hours compared to split times less than 2 hours. That proportion increases to 54 times higher when the split time increases above 4 hours.[134] Another risk factor was revealed in the subsequent analysis related to operators with multiple jobs, which accounted for nearly 15% of the sample size—operators who worked for more than one employer reported reduced off-duty and rest time, leading to an increased potential for symptoms of fatigue.[135]

[129] Mtoi et al., "Modeling Fatigue-Induced Collision Relative Risk: Implications of Service Hours and Fatigue Management Policies on Transit Bus Operators in Florida" (2013).
[130] US DOT, Federal Aviation Administration Advisory Circular No. 117-3. Date: 10/11/12. Fitness for Duty, https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%20117-3.pdf.
[131] Mtoi et al., *op. cit.*
[132] *Ibid.*
[133] Hoang, *op. cit.*
[134] *Ibid*.
[135] *Ibid.*

Other countries have also invested in research to understand the effects of hours of work/service and rest on fatigue, such as the *Journal of Internal Medicine* article "Hours of Work and Rest in the Rail Industry" from Australia in 2013.[136] The article discussed various factors that should be considered in the development of a regulatory framework to mitigate fatigue-related rail safety events. Conclusions detailed that a fatigue regulatory framework should prescribe hours of work and rest, include a comprehensive sleep disorder management program, and use biomathematical modeling and other technologies to manage the risk of fatigue at an organizational level.[137]

Transit Route Scheduling

Transit route scheduling has the potential to affect an operator's ability to perform their assigned duties, with an additional influence on their cognitive ability to stay focused, as noted earlier. The use of biomathematical models to design fatigue out of a transit schedule is beneficial as an optimization tool, which will be explored in more detail in the Biomathematical Models and Other Tools section of the literature review. Just as considering the human inputs to the models is imperative to model performance, it is vitally important that realistic and actual route times are entered in the models as well.

Eventually, although a schedule may include certain time stops and route headways, over time many factors, such as congestion and/or construction change, affect the schedule. If transit agencies are not adequately addressing safety risk management and safety assurance through continuous evaluations of their systems in an ongoing fashion, then there is no way for the agency to adequately modify its route scheduling to reflect actual route schedules. A 2009 Australian study used focus groups comprising bus operators, trainers, assessors, and customer service consultants and determined that fatigue is most effected by tight route schedules, turn-around and shift irregularity, and extended shift cycles, among six other factors.[138] The main factors found to impact tight route schedules included traffic density, variable traffic volume, and longer routes. In addition, the researchers found tight schedules led to time pressures that reduce the ability for operators to take breaks, which increased fatigue.[139]

Training to Recognize Signs/Symptoms

With a long history in fatigue risk management, FAA produced a video in 2011 titled "Grounded" that explains the importance of good sleep habits.[140]

[136] Hours of Work and Rest in the Rail Industry, https://onlinelibrary.wiley.com/doi/full/10.1111/imj.12159.
[137] *Ibid.*
[138] Biggs, Dingsdag, and Stenson, "Fatigue Factors Affecting Metropolitan Bus Drivers: A Qualitative Investigation." *Journal of Prevention, Assessment, and Rehabilitation*, 32(1) (2009): 5-10.
[139] *Ibid.*
[140] https://www.faa.gov/tv/?mediaid=400.

Additionally, computer-based fatigue countermeasure training is available that focuses specifically on aviation maintenance.[141]

Although the dangers associated with driving while fatigued are not refuted, it is difficult to quantify the fatigue-related contributing factors of collisions, specifically because fatigue cannot be directly measured and is typically inferred from subjective assessments in individual collision investigations, at best.[142] Training to recognize typical collision characteristics that may indicate the presence of fatigue and strategies for obtaining the necessary pre-collision information could benefit many transportation industries.

NTSB's course on investigating human fatigue factors focuses on a defined process to determine if the operator was fatigued and if the fatigue contributed to the event.[143] The course recommends the use of key evidence sources such as interviews, schedules/logbooks, cell phone records, audio/video/data recordings, and other timestamped records.[144] This type of crash investigation training is important to ensure that fatigue is considered as a possible contributing factor in collisions to enable data driven mitigation measures to be implemented. Additionally, clarity of terminology definitions in the training would help to remove variation in reporting across jurisdictions.

Reducing fatigue-related accidents is the only factor that has appeared on the NTSB's Most Wanted List since its inception in 2011.[145] Through this overarching safety recommendation, NTSB calls for a comprehensive approach to combatting fatigue in transportation, focusing on research, education, and training. Training is one aspect of fatigue mitigation that should not be overlooked. Fatigue risk management must include not only a fatigue management policy, a fatigue reporting system, and fatigue considerations in incident investigations, but also must include fatigue training and continuous monitoring of the effects of each of the fatigue risk management elements and program improvements.

TCRP Report 81 outlined the five elements that together describe the process of building and maintaining a fatigue management program, including:

- Senior management commitment
- Policy development
- Communication and training

[141] https://www.faa.gov/about/initiatives/maintenance_hf/fatigue/media/fatigue_training_app.zip.
[142] Dawson et al., "Determining the Likelihood that Fatigue was Present in a Road Accident: A Theoretical Review and Suggested Accident Taxonomy," *Sleep Medicine Review*, 42 (2010): 202-210. https://doi.org/10.1016/j.smrv.2018.08.006.
[143] https://www.ntsb.gov/Training_Center/Pages/2019/IM303.aspx.
[144] https://www.cdc.gov/niosh/topics/workschedules/pdfs/NIOSH-Seminar-Investigating-Human-Fatigue-Factors-092717.pdf.
[145] https://www.ntsb.gov/safety/mwl/Pages/mwl_archive.aspx.

- Managing fatigue and alertness
- Monitoring, reviewing and modifying as necessary to improve the program[146]

The authors recommended that training in the transit industry should consist of fatigue awareness training for all stakeholder groups, inclusive of sleep principles, education, and performance consequences of inadequate rest. Additionally, safety-sensitive employees should also receive training on techniques and strategies to minimize the risk of fatigue. Training for management and supervisors is also important, as brief higher-level training will ensure that management can identify fatigue-related incidents and precursors to incidents, understand fatigue-related risks, and establish and/or modify agency fatigue policies and procedures.

The Commercial Truck and Bus Safety Synthesis 13 Report, "Effectiveness of Commercial Motor Vehicle Driver Training Curriculum," identified and documented commercial driver training curriculum and practices, with a focus on both training and training evaluation and improvement.[147] The synthesis provided best practices, instructional technologies, evaluation techniques, and trends in driver training for use by truck and bus carriers and driver training organizations. It included a review of those issues that affect a driver's performance, including fatigue.

Fatigue-related Distractions, Including Cognitive Overload

Fatigue as a performance decrement is defined as "the effects of tiredness on metabolic activity within the prefrontal parietal cortices having consequences for a wide range of cognitive functions, mainly via effects on the prefrontal cortex."[148] In 2012, a former NTSB Chair noted that, "While alcohol is often associated with impairment, operating a vehicle while fatigued can be just as deadly."[149]

In "Directed Attention as a Common Resource for Executive Functioning and Self-Regulation," self-regulation is described as the ability to control oneself and behave in an acceptable manner, even in tempting and/or distracting scenarios. Self-regulation is a limited resource drawn upon by executive functioning, which is the managing of oneself to achieve a goal. Self-regulation and executive functioning are finite and can be depleted. The depletion of self-regulation and executive functioning cause fatigue and impact a person's performance abilities to complete a task. Furthermore, when an individual is forced to divide their attention, their ability to inhibit socially inappropriate responses is

[146] TCRP Report 81, *op. cit.*
[147] http://www.trb.org/Publications/Blurbs/157017.aspx.
[148] Killgore, *op. cit.*
[149] https://www.niehs.nih.gov/news/events/pastmtg/hazmat/assets/2012/20_sleep_sleep_deprivation_and_worker_fatigue_508.pdf.

reduced, confirming that distractions further limit their capacity for response inhibition.[150] Distraction and stress are drawn from a common limited resource known as self-regulation, and the depletion of self-regulation may cause fatigue.[151]

Biomathematical Models and Other Tools

TRACS evaluated the necessary steps to establish a fatigue management program for the bus and rail transit industry. TRACS Report 14-02 included recommendations to FTA on the elements that should comprise a SMS approach to a fatigue management program. In the report, one particular tool that was identified as potentially beneficial was biomathematical modeling to predict fatigue based on physiology and historical effects on human performance.[152] Biomathematical modeling, when validated and calibrated, has reduced fatigue-related risk in other industries. For instance, through federal regulation (49 CFR 228.407), FRA requires the use of validated models such as the FAST and FAID models or other submitted and approved models in the development of scheduling to ensure that fatigue threshold remains at an acceptable level; fatigue threshold is defined as the level of fatigue at which safety may be compromised.[153] The Circadian Alertness Simulator (CAS) was developed and validated for the trucking industry to simulate sleep and alertness measures to determine a fatigue score to be used for schedule optimization, fatigue-related accident investigation, and training in the railroad and trucking industry.[154]

The SAFTE model of human fatigue and circadian variation and the FAST application were developed through sponsored efforts of US DOT and the US Department of Defense. Recently, FRA completed a test of the model and found that model predictions of decreased operator effectiveness were related to increased human factors accident risk. The results of the test found that an increase in human factors accident risk occurs when effectiveness scores were below 70, which is roughly equivalent to being awake for 21 hours following an 8-hour sleep period.[155] The FAST application and SAFTE model estimate fatigue risk, show detail of each schedule, calculate fatigue factors, and suggest

[150] Kaplan and Berman, "Directed Attention as a Common Resource for Executive Functioning and Self-Regulation," *Perspectives on Psychological Science* (2015). http://pps.sagepub.com/content/5/1/43.full.pdf+html.
[151] Tice et al., "Restoring the Self: Positive Affect Helps Improve Self-Regulation Following Ego Depletion," *Journal of Experimental Social Psychology* (2007).
[152] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/TRACS_Fatigue_Report_14-02_Final_(2).pdf.
[153] https://www.govinfo.gov/content/pkg/CFR-2011-title49-vol4/pdf/CFR-2011-title49-vol4-sec228-407.pdf; Roach, Fletcher, and Dawson, "A Model to Predict Work-related Fatigue Based on Hours of Work," *Aviation Space and Environmental Medicine* (2004).
[154] Moore-Ede et al., "Circadian Alertness Simulator for Fatigue Risk Assessment in Transportation: Application to Reduce Frequency and Severity of Truck Accidents," *Aviation Space and Environmental Medicine* (April 2004).
[155] https://ibrinc.org/wp-content/uploads/2016/06/validation-and-calibration-summary-report.pdf

conditions that lead to fatigue so mitigations can be implemented. The FAST application could be examined as a valuable tool to manage fatigue in safety-sensitive public transportation positions.

With recognition of the pervasive risk associated with operator fatigue that is largely unmitigated, underreported, and costly to a transit agency, much research has pointed to the need for comprehensive fatigue risk management programs. Biomathematical modeling is a tool recognized as beneficial for providing schedule outputs that take many complex interactions of fatigue-related characteristics into consideration. However, there are also recognized challenges associated with the use of biomathematical modeling for the optimization of transit operator scheduling, such as required sleep estimate inputs, which must be generalized and, thus, cannot be individualized or account for personal sleep disorder diagnoses, substance use, or other personal behaviors. Lehrer (2015) identified some strengths and weaknesses in biomathematical modeling through revealed gaps in the current models and subsequent improvements proposed for future fatigue modeling in his report "A Systems-Based Framework to Measure, Predict, and Manage Fatigue."[156] This report included a comparison of the features considered in the following 10 sample fatigue performance models:

- Circadian Alertness Simulator (CAS)
- Fatigue Audit InterDyne (FAID)
- Interactive neurobehavioral model (INM)
- System for Aircrew Fatigue Evaluation (SAFE)
- Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE)
- Sleep/Wake Predictor (SWP)
- Biomathematical fatigue model (BFM)
- Fatigue Index Risk Measurement (FIRM) and Predictive Risk Intelligent Safety Module (PRISM)
- Representation and Analysis Software (RAS) and Time Intelligence Solutions (TIS)
- Sleep model (SLEEP)

Lehrer (2018) notes that fatigue models should account for both internal and external contributing fatigue factors and be evaluated on the efficacy, reliability, and validity of the outputs. Internal factors include physiological drivers, performance traits and practices, health and wellness profiles, and demographic characteristics, and external factors include schedule dynamics, task demands, socioeconomic dimensions, and environmental variables.[157]

[156] Lehrer, "A Systems-Based Framework to Measure, Predict, and Manage Fatigue" (May 28, 2018), https://doi.org/10.1177/1557234X15575522.
[157] *Ibid*

In 2011, Dawson et al. found that biomathematical models can be a powerful method for visualizing non-intuitive relationships between variables, such as patterns of work, sleep-wake behavior, and fatigue. However, the models often lead to oversimplification and overreliance in decisionmaking.[158] In practice, the best use of these fatigue models is for determining the relative degree of average sleep afforded by a certain work pattern for a group of employees rather than predicted fatigue for individual employees.[159] There is an urgent need to consider individual variability in biomathematical models of fatigue and performance is present in currently available models.[160] Individual differences is an area that is especially challenging for model prediction outputs due to the necessary presumption of reasonable sleep quality based on averaged expectations.[161] Recommendations from this research included iterative data collection and convergence of algorithms to develop more sophisticated and useful models that can account for individual differences through advances of current models and data collection tools.[162]

In the trucking industry, there is currently a Small Business Innovation Research (SBIR) project being performed through FMCSA to develop advanced modeling, the Trucking Fatigue Meter, which uses individual telematics/electronic logging data and automatic collection of wearable sleep data from drivers to evaluate driver fatigue and "provide actionable feedback in near real-time."[163] If the results of the project reveal the ability to reduce fatigue-related risk using individualized data for scheduling modeling, then there may be potential for pilot projects to determine benefits within transit.

There are inherent challenges with identifying fatigue as an underlying contributing factor in collisions due to the lack of consistent and reliable data related to fatigue. Whereas biomathematical models predict fatigue given specific characteristics, there are not many validated and verified technologies that have been proven to collect accurate fatigue-related data in real time to validate the presence of fatigue as a contributing factor in collisions. To combat this issue, research has correlated the factors associated with fatigue, such as eyelid closure, head position, force of grip, and brainwave activity, to collisions or near-miss events.[164] Additionally, to support this relationship, Guo et al. found

[158] Dawson et al., "Modelling Fatigue and the Use of Fatigue Models in Work Settings," *Accident Analysis & Prevention* 4(2) (March 2011): 549-564. https://doi.org/10.1016/j.aap.2009.12.030.
[159] Ibid.
[160] Van Dongen, Maislin, and Dinges, "Dealing with Inter-Individual Differences in the temporal Dynamics of Fatigue and Performance: Importance and Techniques," *Aviat Space Environ Med*. 75(3) SUPPL (March 2004): A147-54. https://www.ncbi.nlm.nih.gov/pubmed/15018277.
[161] Lehrer, *op. cit.*
[162] *Ibid.*
[163] https://www.fmcsa.dot.gov/safety/research-and-analysis/advanced-fatigue-modeling-individual-differences-phase-iii-sbir.
[164] Hartley et al., "Review of Fatigue Detection and Prediction Technologies" (September 2000), https://pdfs.semanticscholar.org/6061/1349d1b6d64488a5a88a9193e62d9db27b71.pdf

that safety-critical events are reasonable to use as fatigue surrogate measures when the causal mechanisms are similar to known factors associated with fatigue.[165]

Collection of fatigue data, specifically real-time fatigue data collection, is reliant on data collection technology such as the Optalert Alertness Monitoring System (OAMS), which uses infra-red reflectance oculography to monitor eyelid movement, and subsequent blink velocity, from which levels of fatigue can be derived.[166] In this study, participants were monitored for a continuous period of 4–8 weeks and were provided with warnings related to their alertness levels for half of the surveillance time; the other half of the time data was collected with no alerts provided. Results revealed a small but statistically significant increase in alertness, reduced drowsiness, and improved safe distance ratings for mining and road transport drivers who received feedback about their drowsiness.[167] However, the relatively small sample size included in the 2015 study limits the practical benefit assumptions that can be made of the system.

In 2016, Wang et al. set out to find the physical variables that are best at predicting fatigue in drivers. There were 19 driver behavior variables and 4 eye feature variables. Participants drove in a simulated course after an eight-hour night shift. At the midpoint of each of the six rounds for the course, the participants were asked to report their drowsiness level using the Karolinska Sleepiness Scale (a scale that measures subjective sleepiness).[168] A multilevel ordered logit (MOL) model was used to determine drowsiness. It was found that percentage of eyelid closure, average pupil diameter, standard deviation or lateral position, and steering wheel reversals were the variables that best predicted fatigue.[169]

In addition to research that describes the benefits of the use of biomathematical model validation of worker schedules, NTSB recommended that transit agencies work with local unions to "develop and implement a work scheduling program for roadway workers using a validated biomathematical model of fatigue avoidance to ensure that roadway workers at risk of being fatigued are not eligible for overtime (R-20-9)."[170] This recommendation came in response to the fatal collision between an MTA LIRR train and a roadway worker in 2017.

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[165] Guo et al., "Near Crashes as Crash Surrogates for Naturalistic Driving Studies," *Transportation Research Record*, 2147 (2010): 66-74.
[166] Aidman et al., "Real-time Driver Drowsiness Feedback Improves Driver Alertness and Self-Reported Driving Performance," *Accident Analysis & Prevention*, 81 (August 2015): 8-13, https://doi.org/10.1016/j.aap.2015.03.041.
[167] *Ibid.*
[168] https://www.med.upenn.edu/cbti/assets/usercontent/documents/Karolinska%20Sleepiness%20Scale%20(KSS)%20Chapter.pdf.
[169] Wang, "Driver Drowsiness Detection Based on Non-Intrusive Metrics Considering Individual Specifics" (2016).
[170] https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR2001.pdf.

WMATA established a Fatigue Risk Management System to address risk related to fatigue that is consistent with other safety-sensitive industries. WMATA's system includes Fatigue Risk Management policies, with HOS limitations based on the SAFTE-FAST biomathematical fatigue modeling, fatigue training, and fatigue factor considerations in data collection, investigation, and analysis.[171]

Literature Review Summary and Findings

The limited availability of national transit safety event causal and contributing factor related NTD data restricts the ability to understand the impact of fatigue and medical fitness for duty risk factors in the industry. Review of the literature, existing voluntary standards, guidance documents, and other tools and strategies to inform the transit industry revealed significant limitations with current transit safety data reporting. There is a lack of data uniformity, in terms of both definitions and collection methods, that hinders the ability to make collision data comparisons between localities, states, or nationally.[172] This lack of ability to make national data comparison coupled with a lack of consistent fatigue-related detection factors makes the total fatigue-related crash impacts largely under-quantified, subsequently underestimating fatigue effects on safety-sensitive functions.

Robust and mature employee safety reporting programs encourage employees to report fatigue and fitness for duty concerns and is essential for safe transit operations. TCRP Report 81 documents the principles, techniques, and strategies used in the development of fatigue mitigation plans, which includes providing employees an opportunity to report their own fatigue without fear of discipline or retribution.[173] Additionally, the requirement of extensive documentation of occasional and infrequent medical absences, for example, encourages employees to report to work when ill, increasing the likelihood of errors.[174] Development of non-punitive attendance policies that also account for absenteeism requires a delicate balance. TCRP Synthesis 33 recognizes the challenges associated with ensuring that employees are available when needed, noting that lax attendance policies led to increased patterns of absenteeism that can ultimately impact budgets and lead to delays in service and other organizational inefficiencies.[175] However, within that balance, effective attendance policies include procedures that encourage employees to self-report fatigue may impair their ability to perform their duties and may reduce the number of fatigue-related incidents or close calls.

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[171] CUTR Transit Standards Working Group Meeting, July 2018, Fatigue Risk Management at Washington Metropolitan Area Transit Authority.
[172] NHTSA (2017) *MMUCC, 5th Edition*, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812433.
[173] http://www.trb.org/Publications/Blurbs/153765.aspx.
[174] Strauch, *Investigating Human Error: Incidents, Accidents, and Complex Systems, Second Edition* (2017), http://library.sadjad.ac.ir/opac/temp/18494.pdf.
[175] Volinski, TCRP Synthesis 33, "Practices in Assuring Employee Availability," http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn33.pdf.

Consistent definitions and application of minimum employment duty criteria that are classified as safety-sensitive may reduce variability in qualification criteria and reduce incidents. Additionally, requiring pre-employment, regularly scheduled periodic re-examination, and return to duty medical examination certification for all safety-sensitive employees may reduce reportable incidents. In APTA's Standard for Rail Transit Fitness for Duty Program requirements, transit authorities are responsible for identifying the minimum medical requirements related to the job responsibilities of safety-sensitive employees because each transit authority has unique operating characteristics.[176] However, there are key commonalities in all recommendations of fitness for duty testing for safety-sensitive employees, including sleep disorder screening, testing, and treatment.

Verification of explicitly defined minimum medical fitness for duty qualification criteria for employment, through medical examination performed by a certified Medical Examiner, may reduce incidents and improve overall system safety. That medical fitness for duty testing should include testing for sleep disorders and associated practices to reduce the potential risk factors associated with driving while fatigued, as the NTSB recognizes that "the absence of regulations in the railroad industry focused on screening for, diagnosing, and ensuring adequate OSA treatment means that employers may be unaware of their employees' impairing medical conditions or medication use." [177]

HOS policies that define the limits for driving time, time on duty, time off duty between shifts, work week hours, maximum number of consecutive workdays, and emergency service provisions to reduce or mitigate fatigue risk may reduce the number of transit safety events. The development and implementation of fatigue mitigation plans are suggested to minimize fatigue-related risk through the consideration of severity and probability.[178] Furthermore, NTSB determined that without an FRA requirement of HOS regulations, roadway workers are at risk for fatigue-related accidents involving the movement of trains.[179]

The consideration of impacting factors of fatigue on transit worker scheduling and the design of transit worker scheduling tools to mitigate impacting factors of fatigue may reduce the potential for fatigue-related safety events. Studies have shown collision risk increases as driving time increases and as off-duty time decreases. Additionally, collision risks were found to increase for shifts that began between 3:00–6:59 AM (the window of circadian low that is known to occur between 2:00–6:00 AM for individuals adapted to usual day-wake/sleep-night schedules).[180] Additional studies revealed that operators who worked split-

[176] https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-RT-S-OP-018-12-Rev-1-Fitness-for-Duty.pdf.
[177] *Ibid.*
[178] *Ibid.*
[179] https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR2001.pdf.
[180] US DOT, Federal Aviation Administration Advisory Circular No. 117-3. Date: 10/11/12, Fitness for Duty. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%20117-3.pdf.

shift schedules also had longer working days, earlier start times, and later end times, which lead to potential increases in operator fatigue.[181]

The consideration of impacting factors that transit route scheduling may have on inducing operator fatigue may reduce the potential risk factors associated with driving while fatigued and improve an operator's ability to perform their duties as assigned. Studies have revealed that fatigue is effected by tight route schedules, turn-around and shift irregularity, and extended shift cycles, among other factors.[182]

The development of a formal work schedule manager certification program to ensure that all managers have the required expertise to properly create schedules taking employee health, safety, and performance into account may improve the safety of the industry through a reduction in fatigue-related safety events. The literature review revealed the need for additional training for scheduling managers to ensure they understand the impact work schedules have on employee health, safety, and performance and take the impacts into consideration when schedules are made. With a lack of standardized training about impacting factors of fatigue, information is taught through short-term mentorship and on-the-job training, which provides the opportunity for bad habits and bad schedule designs to propagate.[183]

Finally, with the understanding that no model or tool alone can accurately capture all risk, biomathematical models can predict fatigue based on characteristic inputs such as time of day, sleep history, workload, and length of shifts. Biomathematical modeling is a tool recognized as beneficial for providing schedule outputs that take many complex interactions of fatigue-related characteristics into consideration.[184] Biomathematical models can be a powerful method for visualizing non-intuitive relationships between variables such as patterns of work, sleep-wake behavior, and fatigue.[185] The literature review points to the best in practice use of these fatigue models as determinants of relative degrees of average sleep afforded by a certain work patterns for a group of employees rather than predicting fatigue for individual employees.[186]

The literature review supports the same findings revealed in the gap analysis of current available federal standards, state regulations and legislation, other industry recommended practices and guidance documents, and various NTSB recommendations to determine specific fatigue and medical fitness for duty-

[181] Mtoi et al., *op. cit.*
[182] Biggs, et al., *op cit.*
[183] US DOT, 2010, Work Schedule Manager Gap Analysis.
[184] Lehrer, *op. cit.*
[185] Dawson et al. , *op. cit*.
[186] *Ibid.*

related topics. Given the recognition that fatigue and medical fitness for duty are factors specifically recognized in the transportation industry and revealed in accident investigation reports, such those issued by NTSB, the need for guidance in the transit industry is evident.

Appendix B

North American Fatigue Management Program (NAFMP): Learning Modules

Module	Title	Target Audience	Learning Objectives	Estimated Course Duration
1	FMP Introduction and Overview	Motor carrier executives and managers	• Understand Fatigue Management Program (FMP) principles and components. • Understand characteristics of fatigue and health and wellness implications. • Identify benefits of using FMP.	45 min
2	Safety Culture and Management Practices	Motor carrier executives and managers	• Identify safety culture between safety culture and fatigue. • Understand importance of commitment to fatigue management programs from all levels of organization. • Identify importance of fatigue communication, empowering drivers, and building trust. • Identify how to create an FMP committee. • Create policies for recognition. • Identify how to conduct measure FMP effectiveness.	1.5 hrs
3	Driver Education	Commercial drivers	• Understand principles of driver fatigue, alertness, sleep, and wellness. • Understand how to apply knowledge to work duties. • Scheduling and HOS.	3 hrs
4	Driver Family Education	Driver, spouses, and family	• Understand commercial driver fatigue, alertness, sleep, and wellness. • Understand how to apply this knowledge to support better sleep and wellness at home.	45 min
5	Train-the-Trainer for Driver Education and Family Forum	Carrier safety managers and other trainers	• Understand principles and methods of effective teaching. • Understand structure and procedures of FMP. • Understand principles and impacts of driver fatigue, alertness, sleep, and wellness. • Promote fatigue management principles and commitment to a culture of safety.	3.5 hrs

Module	Title	Target Audience	Learning Objectives	Estimated Course Duration
6	Shippers and Receivers	Freight shippers and receivers	• Understand principles of commercial driver fatigue, alertness, and health. • Understand factors that affect fatigue and alertness. • Understand fatigue management challenges and HOS regulations. • Promote team approach to driver compliance, health, and safety.	30 min
7	Motor Carrier Sleep Disorders Management	Motor carrier sleep disorders management	• Understand responsibilities and roles in identifying, treating, and managing sleep disorders. • Identify how to develop and implement a sleep disorders management program. • Promote driver support and encouragement.	1.5 hrs
8	Driver Sleep Disorders Management	Commercial drivers	• Understand sleep disorders, screening, and testing. • Understand regulations and guidelines that impact commercial drivers with sleep disorders. • Identify treatments and benefits. • Identify how sleep disorder management contributes to fatigue management.	1.25 hrs
9	Driver Scheduling and Tools	Dispatchers and driver managers	• Identify factors in driver schedules that contribute to fatigue. • Identify how to maximize the benefits of scheduling tools. • Identify how to develop strategies to manage fatigue and how they can be customized to suit the operation. • Promote importance of shared responsibility in reducing fatigue.	1 hr
10	Fatigue Monitoring and Management Technologies	Motor carrier executives and managers	• Identify and understand fatigue management technologies and their role within a safety culture. • Identify current technologies available. • Understand costs and benefits of implementation. • Identify how to develop and deploy technologies based on operational guidelines within an FMP.	1 hr
ALL				Total Program: 14.75 hrs

Adapted from NAFMP (2014), https://www.nafmp.org/online-courses/who-should-take-the-training.html.

Appendix C

NTSB Investigation Reports and Recommendations

A key source available to identify transportation-related risk is NTSB and its recommendations, which stem from investigations of accidents of many modes. Table C-1 displays the generalized recommendations for various surface transportation modes related to fatigue or medical fitness for duty, along with the current status of the recommendation.

Table C-1 *Fatigue and Fitness for Duty-Related NTSB Recommendations*

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
H-00-006	Fatigue	Greyhound Lines Inc.	Burnt Cabins, PA	01/14/2000	Revise scheduling practices to reduce irregular work-rest cycles.	Closed - Acceptable Action
H-00-010; H-00--11	Fatigue	United Motor Coach Assn.	Burnt Cabins, PA	01/14/2000	Revise scheduling practices to reduce irregular work-rest cycles and include all traffic violations in driver records and consider during safety assessments.	Closed - Acceptable Action
H-00-020	Fatigue	Governors of States	Washington, DC	09/08/2000	Eliminate or modify time limits at public rest areas that prevent truck drivers from obtaining adequate rest.	Closed - Acceptable Action
H-01-030; H-01-031; H-01-032	Fatigue	FHWA	Glendale, CA	12/20/2001	Develop training to address effects of fatigue on performance, among other topics.	Closed - Exceeds Recommended Action
H-01-033	Fatigue	FMCSA, AASHTO, American Assn. of Motor Vehicle Administrators, California Professional Escort Car Assn., Texas Pilot Car Assn., United Safety Car Assn., Commercial Vehicle Safety Alliance, Specialized Carriers and Rigging Assn.	Glendale, CA	12/20/2001	Develop oversize/over-weight vehicle movement guidelines to address issues such as effects of fatigue on performance, among other issues.	Closed - Exceeds Recommended Action
H-07-041	Fatigue	FMCSA	Chelsea, MI	12/17/2007	Require use of electronic data recorders to enable carriers and their regulators to monitor and assess hours-of-service compliance.	Closed - Acceptable Alternate Action

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
H-07-043	Fatigue	Equity Transportation Company, Inc.	Chelsea, MI	12/17/2007	Implement driver log review program to verify driver compliance with federal commercial driver hours-of-service regulations.	Closed - Acceptable Action
H-08-016	Fatigue	Whole Food Market, Inc.	Osseo, WI	02/02/2009	Implement fatigue education program to ensure that employees understand risks of driving while fatigued and comply with fatigue guidelines.	Closed - Acceptable Action
H-09-009; H-09-010	Fatigue	American Bus Assn., United Motor Coach Assn.	Mexican Hat, UT	05/29/2009	Develop contingency plans to ensure trip planning is in place in event of driver fatigue, incapacitation, or illness or in event of trip delays necessitating replacement drivers to avoid hours-of-service violations and inform drivers of their trip's contingency plans.	Open - Await Response
H-09-015	Fitness for Duty	FMCSA	Jackson, TN	10/20/2009	Implement OSA identification program and require medical certification evidence of evaluation and treatment before being granted unrestricted medical certification.	Open - Unacceptable Response
H-09-016	Fitness for Duty	FMCSA	Jackson, TN	10/20/2009	Develop guidance for commercial drivers, employers, and physicians regarding identification and treatment of individuals at high risk of OSA.	Open - Acceptable Response
H-09-032	Fatigue	FMCSA	Victoria, TX	12/29/2009	Update and electronically redistribute "Driver Fatigue" video and implement plan to regularly update and redistribute video.	Closed - Acceptable Alternate Action
H-10-008	Fatigue	FMCSA	Miami, OK	10/21/2010	Create educational materials on fatigue and fatigue countermeasures; make materials available in different formats and implement plan to regularly update educational materials.	Closed - Acceptable Alternate Action

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
H-10-009	Fatigue	FMCSA	Miami, OK	10/21/2010	Require all motor carriers to adopt fatigue management program based on North American Fatigue Management Program guidelines.	Closed - Unacceptable Action
H-10-016	Fatigue	Associated Wholesale Grocers, Inc.	Miami, OK	10/21/2010	Create and implement comprehensive fatigue management program using existing sources of information and develop systematic process to update the program as more guidance becomes available.	Closed - Acceptable Action
H-12-017	Fitness for Duty	FMCSA	New York City, NY	07/12/2012	Include safety measurement system rating scores in methodology used to determine carrier's fitness to operate in safety fitness rating rulemaking for new Compliance, Safety, and Accountability initiative.	Open - Unacceptable Response
H-12-018	Fitness for Duty	FMCSA	New York City, NY	07/12/2012	Include structured audit process in safety fitness rating rulemaking to identify root cause of safety risks and deliver guidance to ensure promotion of safety management.	Closed - Acceptable Alternate Action
H-17-049	Fitness for Duty	FMCSA	Palm Springs, CA	11/21/2017	Make recommendations on screening for OSA easily accessible to CMEs and instruct examiners to use recommendations as guidance when evaluating commercial drivers for OSA risk.	Open Acceptable Alternate Response
H-17-050	Fitness for Duty	FMCSA	Palm Springs, CA	11/21/2017	Provide clear guidance for CMEs to use when evaluating commercial drivers who are not known to have diabetes but who have glucose in their urine.	Open - Acceptable Response
H-17-056	Fatigue	US Department of Labor	St. Marks, FL	01/04/2018	Develop guidelines and training material for agricultural employers and farm labor contractors on dangers of driving while tired and on strategies for managing driver fatigue.	Open - Acceptable Response

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
H-18-051	Fitness for Duty	FMCSA	Laredo, TX	12/04/2018	Develop guidance for CMEs to use when making medical certification decisions regarding drivers with diabetes who are not treated with insulin, including certification time limits and disqualifying results.	Open - Acceptable Response
H-89-031	Fitness for Duty	FHWA	Nashville, TN	09/28/1989	Prohibit omission of medical information in connection with medical certification physical examination.	Closed - Unacceptable
H-90-029	Fatigue and Drug & Alcohol	FHWA	Washington, DC	04/04/1990	Investigate interactions of fatigue and drug usage.	Closed - Unacceptable
H-90-048	Fatigue	States, Commonwealth of Puerto Rico, Virgin Islands, Territories	Washington, DC	04/04/1990	Require automated/ tamper-proof on-board recording devices such to identify commercial truck drivers who exceed HOS regulations.	Closed - Unacceptable Action - No Response Received
H-95-040	Fatigue	American Assn. of Motor Vehicle Administrator	White Plains, NY	11/27/1995	Include information on role of fatigue in commercial vehicle accidents and methods to identify and address fatigue in CDL manual and test materials.	Closed - Unacceptable Action - No Response Received
H-99-004A	Fatigue	US DOT	Washington, DC	02/26/1999	Require that FHWA fatigue video for motorcoaches include dangers of inverted duty-sleep periods.	Closed - Acceptable Action
H-99-010; H-99-011; H-99-012; H-99-015; H-99-016	Fatigue	American Bus Assn.	Washington, DC	02/26/1999	Alert members of dangers of inverted duty-sleep periods. Encourage members to revise scheduling practices to avoid inverted duty-sleep periods or to provide a relief driver if schedule requires alternate night driving. Include explanation of dangers of inverted duty-sleep periods in bus driver fatigue training video currently under production.	Closed - Acceptable Action

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
H-99-019	Fatigue	FMCSA	Washington, DC	06/01/1999	Establish hours-of-service regulations that set limits on HOS, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. Revised regulations should also require sufficient rest provisions to enable at least 8 continuous hours of sleep after driving for 10 hours or being on duty for 15 hours and eliminate permission to accumulate 8 hours of off-duty time in two separate periods.	Closed - Acceptable Alternate Action
R-09-009	Fitness for Duty	FTA	Newton, MA	07/23/2009	Develop and disseminate guidance regarding identification and treatment of individuals at high risk for OSA and other sleep disorders.	Closed - Acceptable Action
R-12-016	Fitness for Duty	FRA	Red Oak, IA	05/10/2012	Require railroads to medically screen employees in safety–sensitive positions for sleep apnea and other sleep disorders.	Open - Unacceptable Response
R-12-017	Fatigue	FRA	Red Oak, IA	05/10/2012	Establish program to monitor, evaluate, report on, and continuously improve fatigue management systems to identify, mitigate, and continuously reduce fatigue-related risks for personnel performing safety-critical tasks, with particular emphasis on biomathematical models of fatigue.	Open - Acceptable Response
R-12-018	Fatigue	FRA	Red Oak, IA	05/10/2012	Conduct research on new and existing methods that can identify fatigue and mitigate performance decrements associated with fatigue in on-duty train crews.	Open - Acceptable Response

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
R-12-019	Fatigue	FRA	Red Oak, IA	05/10/2012	Require implementation of methods that can identify fatigue and mitigate performance decrements associated with fatigue in on-duty train crews identified or developed in response to Safety Recommendation R-12-18.	Open - Acceptable Response
R-12-025	Fatigue	BNSF Railway	Red Oak, IA	05/10/2012	Require employees and managers who perform or supervise safety-critical tasks to complete fatigue training on annual basis and document when they received training.	Open Acceptable Alternate Response
R-13-018	Fitness for Duty	FRA	Goodwell, OK	08/14/2013	Determine what constitutes a reliable, valid, and comparable field test procedure for assessing color discrimination capabilities of employees in safety-sensitive positions.	Open - Unacceptable Response
R-13-019	Fitness for Duty	FRA	Goodwell, OK	08/14/2013	Require railroads to use reliable, valid, and comparable field test procedure for assessing color discrimination capabilities of employees in safety–sensitive positions.	Open - Unacceptable Response
R-13-020	Fitness for Duty	FRA	Goodwell, OK	08/14/2013	Require more frequent medical certification exams for employees in safety-sensitive positions who have chronic conditions with potential to deteriorate sufficiently to impair safe job performance.	Open - Unacceptable Response

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
R-13-021	Fitness for Duty	FRA	Goodwell, OK	08/14/2013	Develop medical certification regulations for employees in safety-sensitive positions that include complete medical history, screening for sleep disorders, review of current medications, and thorough physical examination; standardization of testing protocols across industry; centralized oversight of certification decisions; consider requiring medical examinations be performed by those with specific training and certification in evaluating medication use and health issues related to occupational safety on railroads.	Open - Unacceptable Response
R-13-030	Fitness for Duty	Union Pacific	Goodwell, OK	08/14/2013	Ensure personnel in safety-sensitive positions have adequate documentation of appropriate medical testing.	Open - Acceptable Response
R-13-031	Fitness for Duty	Union Pacific	Goodwell, OK	08/14/2013	Replace color vision field test with test that has established and acceptable levels of reliability, validity, and comparability.	Open - Acceptable Response
R-13-032	Fitness for Duty	Union Pacific	Goodwell, OK	08/14/2013	Perform safety analysis and undertake measures to manage risk created by use of inadequate color vision field test.	Open - Acceptable Response
R-13-033	Fitness for Duty	Union Pacific	Goodwell, OK	08/14/2013	Retest employees in safety-sensitive positions who failed primary color vision testing on their last medical certification exam using newly implemented color vision field test procedure.	Open - Acceptable Response
R-14-062	Fitness for Duty	Metro-North Railroad	United States	11/08/2019	Revise medical protocols for employees in safety-sensitive positions to include specific protocols on sleep disorders, including OSA.	Closed - Acceptable Action

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
R-14-064; R-14-065	Fitness for Duty	Metro-North Railroad	United States	11/08/2019	Develop and implement protocols to screen and evaluate safety-sensitive employees for sleep disorders and ensure disorders are adequately addressed if diagnosed.	Closed - Acceptable Action
R-14-071	Fitness for Duty	Assn. of American Railroads, APTA, American Short Line and Regional Railroad Assn., Brotherhood of Locomotive Engineers, International Assn. of Sheet Metal, Air, Rail and Transportation Workers	United States	11/24/2014	Develop model national labor agreement that supports effective programs for addressing sleep disorders and other medical conditions among safety-sensitive train operating personnel.	Open Acceptable Alternate Response
R-14-072; R-14-073	Fitness for Duty	American College of Physicians	United States	11/24/2014	Enhance training to ensure Board-certified physicians can successfully identify and evaluate risk factors for OSA and effectively treat OSA.	Closed - Acceptable Action
R-15-018	Fatigue	FTA	Chicago, IL	05/13/2015	Develop and implement work-scheduling program for rail transit agencies that incorporates fatigue science and provides for management of personnel fatigue risks.	Open - Acceptable Response
R-15-020	Fatigue	FTA	Chicago, IL	05/13/2015	Identify necessary training and certification needs for work schedulers in rail transit industry and require transit agencies provide training/certification for work schedulers.	Open - Acceptable Response
R-15-021	Fatigue	FTA	Chicago, IL	05/13/2015	Require rail transit employees who develop work schedules to complete training based on current fatigue science to identify and mitigate work schedule risks that contribute to operator fatigue.	Open - Acceptable Response

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
R-16-043	Fatigue	FRA	Hoxie, AR	01/24/2017	Require freight railroads to use validated biomathematical fatigue models to develop work schedules that do not pose an excessive risk of fatigue.	Open - Unacceptable Response
R16–044	Fitness for Duty	FRA	Hoxie, AR	01/24/2017	Develop and enforce medical standards that railroad employees in safety-sensitive positions diagnosed with sleep disorders must meet to be considered fit for duty.	Open - Unacceptable Response
R-16-045; R-16-047	Fitness for Duty	BNSF Railway, Canadian National Railway, Canadian Pacific Railway, CSX Transportation, Kansas City Southern Railway, Norfolk Southern Railway, Intercity Railroads, Commuter Railroads	Hoxie, AR	01/24/2017	Review and revise medical rules, standards, or protocols to require employees in safety-sensitive positions report diagnosed sleep disorders; when employee makes such a report, perform periodic evaluations to ensure condition is appropriately treated and employee is fit for duty.	Open - Await Response Open- Acceptable Response
R-16-046	Fatigue	Class I Railroads	Hoxie, AR	01/24/2017	Revise scheduling practices for train crews and implement science-based tools such as validated biomathematical models to reduce start time variability that results in irregular work-rest cycles and fatigue.	Open - Await Response
R-18-004	Fitness for Duty	New Jersey Transit and Metropolitan Transportation Authority	Hoboken, NJ	02/14/2018	Ensure operator impairment due to medical conditions, including OSA, is part of hazard management portion of system safety program plan.	Open - Acceptable Response
R-06-003	Fatigue	FTA	Washington, DC	04/19/2006	Require transit agencies to ensure that time off between daily tours of duty, including regular and overtime assignments, allows train operators to obtain at least 8 hours of uninterrupted sleep.	Open - Acceptable Response
R-02-023	Fatigue	Canadian National Railway	Clarkston, MI	11/27/2002	Require employees in safety-sensitive positions take fatigue awareness training and document when employees have received this training.	Closed - Acceptable Action

NTSB Rec. Number	General Topic	Agency	Location	Date	General Recommendation	Current Status
R-99-002	Fatigue	FRA	Washington, DC	06/01/1999	Establish hours-of-service regulations that set limits on HOS, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements.	Closed - Reconsidered
R-96-020	Fitness for Duty	FTA	Brooklyn, NY	09/11/1996	Develop fatigue educational awareness program and distribute to transit agencies for use in fitness for duty training for supervisors & employees involved in safety-sensitive activities.	Closed - Acceptable Action
R-84-027	Fatigue	Metro Rail System, Miami-Dade	Miami, FL	05/15/1984	Limit duty time of train operators, train controllers, and train dispatchers to not more than 12 hours in a 24-hour period and not more than 60 hours in a 7-day week.	Closed - Acceptable Action

Some key recommendations are highlighted in more detail, with the recipient of the recommendation and links to the investigation reports included. The following recommendations were made to various US DOT modal administrations and other groups in response to NTSB investigation findings related to fatigue:

- *Recommendation H–89–031 to FHWA*: Revise Section 391.43 of FMCSR to incorporate a provision that will prohibit the omission of medical information in connection with a medical certification physical examination; require that when commercial drivers are examined, they sign a statement certifying that the medical history they have provided is both complete and accurate and that the motor carrier has the authority to obtain information on the bus drivers' medical history from their personal health care providers; and require that the medical history form elicit more complete information on drivers, using commonly understand able terminology.[187]
- *Recommendation H–90–029 to FHWA:* As part of the FHWA ongoing study of fatigue and loss of alertness among commercial vehicle operators, investigate the interactions of fatigue and drug usage.[188]

[187] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–89–031.
[188] https://ntsb.gov/safety/safety-recs/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H-90-029

- *Recommendation H–95–040 to American Association of Motor Vehicle Administrators in cooperation with FHWA and American Trucking Association*: Review and augment the CDL manual and test materials to include information on the role of fatigue in commercial vehicle accidents and methods to identify and address fatigue.[189]
- *Recommendation H–00–014 to the Federal Motor Carrier Safety Administration (FMCSA):* Establish and implement an educational program targeting highway vehicle operators that, at a minimum, ensures that all operators are aware of the source of information described in Safety Recommendation H–00–13 regarding the hazards of using specific medications when driving.[190]
- *R–09–009 to FTA*: Develop and disseminate guidance for operators, transit authorities, and physicians regarding the identification and treatment of individuals at high risk for OSA and other sleep disorders.[191]
- *Recommendation H–09–015 to FMCSA*: Implement a program to identify commercial drivers at high risk for OSA and require that those drivers provide evidence through the medical certification process of having been appropriately evaluated and, if treatment is needed, effectively treated for that disorder before being granted unrestricted medical certification.[192]
- *Recommendation H–09–016 to FMCSA:* Develop and disseminate guidance for commercial drivers, employers, and physicians regarding the identification and treatment of individuals at high risk of OSA, emphasizing that drivers who have OSA that is effectively treated are routinely approved for continued medical certification.[193]
- *Recommendation H–10–009 to FMCSA:* Require all motor carriers to adopt a fatigue management program based on the North American Fatigue Management Program guidelines for the management of fatigue in a motor carrier operating environment.[194]
- *Recommendation R–12–016 to FRA:* Require railroads to medically screen employees in safety–sensitive positions for sleep apnea and other sleep disorders.[195]

[189] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–95–040.
[190] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–00–014.
[191] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–09–009.
[192] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–09–015.
[193] http://www.ntsb.gov/investigations/data/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–09–016.
[194] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–10–009.
[195] http://www.ntsb.gov/investigations/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–12–016.

- *Recommendation R–13–018 to FRA:* Determine what constitutes a reliable, valid, and comparable field test procedure for assessing the color discrimination capabilities of employees in safety-sensitive positions.[196]
- *Recommendation R–13–019 to FRA:* When a determination has been made in Safety Recommendation R–13–018, require railroads to use a reliable, valid, and comparable field test procedure for assessing the color discrimination capabilities of employees in safety-sensitive positions.[197]
- *Recommendation R–13–020 to FRA:* Require more frequent medical certification exams for employees in safety-sensitive positions who have chronic conditions with the potential to deteriorate sufficiently to impair safe job performance.[198]
- *Recommendation R–13–021 to FRA*: Develop medical certification regulations for employees in safety-sensitive positions that include, at a minimum, (1) a complete medical history that includes specific screening for sleep disorders, a review of current medications, and a thorough physical examination, (2) standardization of testing protocols across the industry, and (3) centralized oversight of certification decisions for employees who fail initial testing; and consider requiring that medical examinations be performed by those with specific training and certification in evaluating medication use and health issues related to occupational safety on railroads. [This recommendation supersedes Safety Recommendations R–02–24 through 26.][199]
- *Recommendation R–13–030 to Union Pacific Railroad:* Audit medical records to ensure that all personnel in safety-sensitive positions have adequate documentation of appropriate medical testing.[200]
- *Recommendation R–13–031 to Union Pacific*: Replace color vision field test with a test that has established and acceptable levels of reliability, validity, and comparability to ensure that certified employees in safety-sensitive positions have sufficient color discrimination to perform safely.[201]
- *Recommendation R–13–032 to Union Pacific*: Until implementation of a validated, reliable, and comparable color vision field test, perform a safety analysis and undertake measures to manage the risk created by the use of

[196] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–018.
[197] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–019.
[198] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–020.
[199] http://www.ntsb.gov/investigations/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–021.
[200] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–030.
[201] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.

an inadequate test. Such measures might include, but are not limited to, restricting crewmembers who have failed primary color vision testing to yard assignments or un-signaled territory.[202]

- *Recommendation R–13–033 to Union Pacific*: Once replacement color vision field test is implemented, retest all certified Union Pacific Railroad employees in safety-sensitive positions who failed the primary color vision testing on their last medical certification exam using the new procedure.[203]
- *Recommendation R–14–062 to Metro–North Railroad:* Revise medical protocols for employees in safety-sensitive positions to include specific protocols on sleep disorders, including OSA.[204]
- *Recommendation R–14–064 to Metro–North Railroad*: Develop and implement protocols to routinely screen and fully evaluate safety-sensitive employees for sleep disorders and ensure that such disorders are adequately addressed if diagnosed.[205]
- *Recommendation R–14–065 to the Long Island Railroad*: Develop and implement protocols to routinely screen and fully evaluate safety-sensitive employees for sleep disorders and ensure that such disorders are adequately addressed, if diagnosed.[206]
- *Recommendation R–14–071 to AAR, APTA, American Short Line and Regional Railroad Association, Brotherhood of Locomotive Engineers, and International Association of Sheet Metal, Air, Rail and Transportation Workers:* Collaborate to develop a model national labor agreement that supports effective programs for addressing sleep disorders and other medical conditions among safety-sensitive train operating personnel.[207]
- *Recommendation R–14–072 to the American College of Physicians:* Enhance initial and ongoing training to ensure that Board-certified physicians in Internal Medicine can successfully identify the risk factors for, evaluate, and effectively treat OSA among their patients.[208]
- *Recommendation R–14–073 to the American Academy of Family Physicians*: Enhance initial and ongoing training to ensure that Board-certified physicians in family medicine can successfully identify risk factors for, evaluate, and effectively treat OSA among their patients. [209]

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[202] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–032.
[203] http://www.ntsb.gov/investigations/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–13–033
[204] http://www.ntsb.gov/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=A–14–062.
[205] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–82–064.
[206] http://www.ntsb.gov/safety/safety–recs/RecLetters/R–14–065.pdf.
[207] http://www.ntsb.gov/investigations/data/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=A–14–071.
[208] http://www.ntsb.gov/safety/safety–recs/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–14–072.
[209] http://www.ntsb.gov/safety/safety–recs/RecLetters/R–14–073.pdf.

- *Recommendation R–15–018 to FTA*: Develop a work scheduling program for rail transit agencies that incorporates fatigue science—such as validated bio–mathematical models of fatigue—and provides for the management of personnel fatigue risks and implement the program through the state safety oversight program.[210]
- *Recommendation R–15–020 to FTA:* Identify the necessary training and certification needs for work schedulers in the rail transit industry and require the transit agencies—through the state safety oversight program—to provide additional training or certification for their work schedulers.[211]
- *Recommendation R–15–021 to FTA*: Require (through the State Safety Oversight Program) rail transit employees who develop work schedules to complete initial and recurrent training based on current fatigue science to identify and mitigate work schedule risks that contribute to operator fatigue.[212]
- *Recommendation H–15–43 to the American Bus Association, American Trucking Associations, Commercial Vehicle Safety Alliance, Owner–Operator Independent Drivers Association, United Motorcoach Association:* Inform members about the dangers of driver use of synthetic drugs and encourage them to take steps to prevent drivers from using these substances.[213]

[210] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–15–018.
[211] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–15–020.
[212] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=R–15–021.
[213] http://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=H–15–043.

Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ANRPM	Advanced Notice of Proposed Rulemaking
APTA	American Public Transportation Association
BFM	Biomathematical Fatigue Model
CAS	Circadian Alertness Simulator
CCT	Customized Community Transportation
CFR	Code of Federal Regulations
CPUC	California Public Utilities Commission
CUTR	Center for Urban Transportation Research
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act
FAID	Fatigue Audit InterDyne
FIRM	Fatigue Index Risk Measurement
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HIPAA	Health Insurance Portability and Accountability Act
HOS	Hours of Service
IDEA	Innovations Deserving Exploratory Analysis
INM	Interactive Neurobehavioral Model
IR	Infrared
MAP-21	Moving Ahead for Progress in the 21st Century Act
MAO	Medical Assessment Officer
MRO	Medical Review Officer
MTA	Metropolitan Transportation Authority
NAFMP	North American Fatigue Management Program
NASA	National Aeronautics and Space Administration
NCHRP	National Cooperative Highway Research Program
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
OAMS	Optalert Alertness Monitoring System
OSHA	Occupational Safety and Health Administration
OSA	Obstructive Sleep Apnea

OTC	Over the Counter
PD	Police Department
PHMSA	Pipeline and Hazardous Materials Safety Administration
PRISM	Predictive Risk Intelligent Safety Module
PTASP	Public Transportation Agency Safety Plan
RAS	Representation and Analysis Software
RTA	Rail Transit Agency
ROI	Return on Investment
Rx	Prescription Drug
SA	Safety Assurance
SAFE	System for Aircrew Fatigue Evaluation
SAFTE	Sleep, Activity, Fatigue, and Task Effectiveness Model
SEPTA	Southeastern Pennsylvania Transportation Authority
SLEEP	Sleep Model
SME	Subject Matter Expert
SMS	Safety Management System
SOP	Standard Operating Procedure
SRM	Safety Risk Management
SSO	State Safety Oversight Program
SSOA	State Safety Oversight Agency
SWP	Sleep/Wake Predictor
TCRP	Transit Cooperative Research Program
TIS	Time Intelligence Solutions
TRACS	Transit Advisory Committee for Safety
TRB	Transportation Research Board
TRI	Office of Research, Demonstration, and Innovation
TSI	Transportation Safety Institute
TSO	Office of Transit Safety and Oversight
TSS	Transit System Security
TSSP	Transit Safety and Security Program
TWU	Transport Workers Union
US.C.	United States Code
US DOT	U.S. Department of Transportation
WMATA	Washington Area Metropolitan Transit Authority

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