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Perspectives on Human Performance and Safety Management in NTSB Rail and Highway Accident Investigations

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ABSTRACT

The National Transportation Safety Board (NTSB) investigates accidents across transportation modes and maintains a Most Wanted List of transportation safety issues based on these investigations. This paper examines three investigations of rail and highway accidents conducted by the NTSB, highlighting the human performance safety issues of employee fatigue and distracted driving. The probable causes and safety recommendations resulting from these investigations are reviewed.

Keywords: Safety management, Human performance, Fatigue, Distraction, Rail safety, Highway safety

INTRODUCTION

The National Transportation Safety Board (NTSB) is charged by the U.S. Congress to investigate certain transportation accidents, determine the probable cause, and issue safety recommendations aimed at preventing similar accidents in the future. The NTSB investigates crashes in the modes of aviation, rail, pipeline and hazardous materials, highway, and marine[1].

Safety recommendations address specific issues uncovered in the investigation and specify actions to help prevent similar accidents from occurring in the future. These safety recommendations are the NTSB's primary product for improving transportation safety.

Based on this process, the NTSB compiles a Most Wanted List (MWL) of safety improvements for Highway, Rail, Pipeline, Hazardous Materials, Marine and Aviation areas of transportation. The MWL highlights transportation safety improvements to be implemented now to save lives. This paper focuses on two human performance safety areas in the Rail and Highway transportation modes that are foundational in safety management, that is, addressing employee fatigue and distracted driving.

NTSB'S MOST WANTED LIST ITEMS FOR RAIL AND HIGHWAY TRANSPORTATION

Rail

The current MWL includes one issue area in rail: Improve Rail Worker Safety. This focuses on improving safety for train crews, rail maintenance-of-way

[1]Some of the opinions expressed are the authors and do not express the views or opinions of the NTSB.

employees and mechanical workers who work on or near the railroad tracks. One of the recurring safety issues for rail roadway workers is preventing employee fatigue due to extensive overtime schedules. The use of fatigue science in developing new overtime scheduling practices is a means to reduce worker fatigue and improve safety, developing both regular and new overtime scheduling practices. Fatigue is a continuing safety concern at the NTB for all modes of transportation. It has been on the MWL in various forms since its inception and most of the following years.

Highway

In 2020, there were more than 38,000 fatalities in motor vehicle traffic crashes, a 7 percent increase compared to the total number of fatalities in 2019.[2] The 2021-2022 MWL includes 5 areas in the highway mode:

> Implement a Comprehensive Strategy of Eliminating Speeding-Related Crashes
> Protect Vulnerable Road Users through a Safe System Approach
> Prevent Alcohol- and Other Drug-Impaired Driving
> Require Collision-Avoidance and Connected-Vehicle Technologies on all Vehicles, and

Eliminate Distracted Driving. This list focuses on some of the leading factors related to roadway fatalities. It also addresses some strategies to take to mitigate fatalities and injuries. In this paper, we will focus on eliminating distracting driving.

ITEMS REGARDING HUMAN PERFORMANCE AND SAFETY MANAGEMENT

NTSB investigators tailor their investigative techniques, which may vary across the transportation modes and accidents. The human performance portion of the accident investigation includes the factors of fatigue and distraction. An example of the investigative process includes these steps:

1. Was the employee fatigued or distracted at the time of the accident? If yes:
2. Did the employee's fatigue or distraction impact their job performance? If yes:
3. Did the employee's impacted job performance cause or contribute to the accident?
4. What was the root cause of the employee's fatigue or distraction?
5. What actions can be recommended, to ensure this type of accident does not occur again?

Fatigue

In determining if the employee was fatigued at the time of the accident, evidence is gathered from many sources which include interviews, personal electronic devices, work schedules, management practices, labor/management

[2]National Highway Traffic Safety Administration (May 2021). Early Estimate of Motor Vehicle Traffic Fatalities in 2020. Traffic Safety Facts. DOT HS 813 115.

agreements on overtime and break rests, and the organization's safety management plan, to include a fatigue risk management plan. Interviews are conducted with the employee, and additional interviews may include the employee's supervisor, members of their work crew, and witnesses to the accident. Data from these interviews inform an understanding of the employee's days leading up to the accident, including timelines for sleep/awake history (including naps), meals, commuting and leisure activities.

The information gathered from the evidence is useful for determining if fatigue factors played a role in the accident's occurrence. Fatigue factors addressed include the length of continuous sleep opportunity, the quality of sleep, the continuous time awake prior to the accident, and circadian rhythms and disruptions. In addition, human performance investigators work with medical officers to gather evidence that may lead to a determination of sleep or medical disorders. If fatigue factors exist, investigators then look to see if the employee's performance was impacted by fatigue, or if other factors, such as medical conditions, were involved.

Distraction

Distraction is often associated with cell phone use, however, distraction can be attributed to other actions such as eating or drinking, reaching for an object, carelessness, or lost in thought. According to the National Highway Traffic Safety Administration (NHTSA), there were 2,895 fatal roadway crashes that involved distraction nationwide in 2019. Of these, 387 were fatal crashes involving cell phones (13 percent of all distraction-affected fatal crashes).[3] Elimination of distracted driving for all drivers, including the use of cellphones or portable electronic devices for calls and texting, has been on the NTSB's MWL since 2013. The NTSB has issued recommendations for more traditional methods of preventing portable electronic device use while driving such as education or legislation but has also stressed the importance of integrating technology into the solution.

Determining whether or not an operator is distracted relies on several pieces of information. In most situations, cell phone records are reviewed to identify if a driver was making or receiving a phone call or a text or if the operator was having a conversation. Sometimes cameras or video recordings are available for review. Witness statements or operator interview statements are also used to establish the potential for operator distraction.

INVESTIGATIVE EXAMPLES

Fatigue, a Rail Accident Investigation Example

A NTSB rail accident investigation that resulted in safety recommendations to prevent worker fatigue occurred on Long Island Rail Road in Queens Village, NY, on June 10, 2017.[4]

[3]National Highway Traffic Safety Administration (2021). Distracted Driving 2019. Traffic Safety Facts Research Note. DOT HS 813111.

[4]National Transportation Safety Board. 2020. Long Island Rail Roadway Worker Fatality, Queens Village, New York, June 10, 2017. NTSB/RAR-20/01.

A crew of rail roadway workers was working on the rail tracks in Queens Village, New York on the morning of the Belmont Stakes horse races. This was one of the busiest days of the year for rail traffic in this area. The crew foreman and three roadway workers were on the tracks inspecting and making repairs. One of the workers was a watchman/lookout for the rest of the workers. As a train approached, the watchman/lookout sounded a handheld horn and yelled at the other workmen to alert them to clear the track. He also raised a paddle which signaled the locomotive engineer to sound the train's horn, which the locomotive engineer did. As the train approached, traveling 78 mph, three of the roadway workers acknowledge they were clear of its track. However, the foreman did not acknowledge the warnings. He stepped into the path of the train and was killed.

Worker fatigue was among the safety issues identified during the accident investigation. The watchman/lookout and foreman worked consecutive overtime shifts that disrupted their circadian rhythms and their opportunities for restorative sleep during the two days prior to the accident. Fatigue decreases alertness and can result in workload shedding, delayed reactions, and poor decisions. The labor management agreement in place at the time of the accident between the LIRR management and unions included overtime offered to employees based on their seniority at LIRR. The scheduling of overtime did not include limiting workers' continuous work hours nor mitigating fatigue risk. Among the investigation's conclusions: roadway workers are at risk from fatigue-related accidents when management-labor contracts do not include limiting overtime work hour to address the risk of fatigue. The NTSB determined the probable cause of the accident was the use of train approach warning to protect the roadway workers on active tracks. In addition, Long Island Rail Road's and the workers' union allowing overtime work schedules without mitigating workers' risk of fatigue was determined to contribute to the accident.

The NTSB has issued over 200 safety recommendations that address fatigue as a contributing or root cause of accidents in rail, highway, marine, aviation, and pipeline accidents. As a result of the Queens Village, NY accident investigation, the following new three safety recommendations were made regarding fatigue:

"To the Federal Railroad Administration:

- Promulgate scientifically based hours of service requirements for roadway workers. (R-20-7)

To the Metropolitan Transportation Authority

- Work with the International Association of Sheet Metal, Air, Rail and Transportation Workers 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)

To the International Association of Sheet Metal, Air, Rail and Transportation Workers:

- Work with Metropolitan Transportation Authority management 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-20-10)" (NTSB, 2020 (1))

Driver Distraction, Highway Investigation Examples

In 2020, the NTSB completed an investigation of a collision of a 2017 Tesla Model CP100D electric-powered sport utility vehicle (SUV) with a crash attenuator in Mountain View, California where the driver was distracted by a cell phone game and over-relied on the vehicle's partial driving automation system.[5] The SUV was traveling south on US highway 101 in the second lane from the left. At this location, US-101 has six southbound traffic lanes, including a high-occupancy vehicle (HOV) exit lane to State Route 85 (SR-85) southbound on the far left. As the SUV approached the US-101-SR-85 interchange, it was traveling in the lane second from the left, which was an HOV lane for continued travel on US-101. While approaching a paved gore area dividing the main travel lanes of US-101 from the SR-85 left-exit ramp, the SUV moved to the left and entered the gore. The vehicle continued traveling through the gore and struck a damaged and nonoperational crash attenuator at a speed of about 71 mph. The Tesla SUV was involved in subsequent collisions with two other vehicles, a 2010 Mazda 3 and a 2017 Audi A4. The Tesla's high-voltage battery was breached in the collision and a postcrash fire ensued. The driver of the of the SUV died, the driver of the Mazda sustained minor injuries, and the driver of the Audi was uninjured.

System performance data downloaded from the Tesla indicated that the driver was operating the SUV using the Traffic-Aware Cruise Control (an adaptive cruise control system) and Autosteer system (a lane-keeping assist system), which are advanced driver assistance systems in Tesla's "Autopilot" suite.

The NTSB determined the probable cause of the crash was the Tesla Autopilot system steering the sport utility vehicle into a highway gore area due to system limitations, and the driver's lack of response due to distraction likely from a cell phone game application and overreliance on the Autopilot partial driving automation system. Contributing to the crash was the Tesla vehicle's ineffective monitoring of driver engagement, which facilitated the driver's complacency and inattentiveness. Contributing to the severity of the driver's injuries was the vehicle's impact with a crash attenuator barrier that was damaged and nonoperational at the time of the collision due to the California Highway Patrol's failure to report the damage following a previous crash, and systemic problems with the California Department of Transportation's maintenance division in repairing traffic safety hardware in a timely manner.

[5] National Transportation Safety Board. 2020. Collision Between a Sport Utility Vehicle Operating with Partial Driving Automation and a Crash Attenuator, Mountain View, California, March 23, 2018. NTSB/HAR-20/01. https://www.ntsb.gov/investigations/AccidentReports/Reports/HAR2001.pdf

The NTSB issued several recommendations addressing the driver distraction component of the crash by issuing recommendations focused on vehicle design to prevent driver misuse of automation in vehicles to ensure that drivers don't disengage from the driving task (H-20-2, H-20-3, H-20-4). Safety Recommendations were also issued asking cell phone manufacturers to develop a distracted driving lock-out mechanism to automatically disable any driver-distracting functions when a vehicle is in motion (H-20-8).

More recently, the NTSB investigated a 2019 crash involving a collision between a SUV and a medium-size bus transporting adult passengers with disabilities and special needs.[6] An SUV was traveling east on US highway 76 in Belton, South Carolina. Meanwhile, a medium-size bus occupied by a driver and 7 passengers, 2 of whom were seated in wheelchairs – was traveling west on US-76 at a speed of about 45 mph. According to a witness following behind the SUV, the SUV was travelling erratically across the lanes. The SUV accelerated to a speed of about 75 mph and, about 1-2 seconds before the impact, crossed the center line and subsequently collided with the left side of the bus, intruding into the bus just behind the driver. The unbelted SUV driver was ejected and fatally injured. A lap-belted bus passengers seated in the intrusion area sustained fatal injuries and the remaining bus occupants sustained minor to serious injuries.

Leading up to the crash, the driver of the SUV had engaged in a 16-minute phone call with a friend that ended less than a minute before the collision. During that conversation, the SUV driver received two incoming calls that she did not answer. She ended the first phone call and placed a call on her cell phone to the incoming number. The driver's outgoing call went to voicemail. Following this call, several incoming calls went unanswered.

The NTSB determined that the probable cause of this crash was the SUV driver's loss of control of her vehicle due to distraction from cell phone use, resulting in the SUV crossing into the opposite travel lane and colliding with the medium-size bus. Contributing to the severity of the crash was the excessive speed of the SUV.

As a result of this crash the NTSB reiterated two recommendations regarding cell phone use. First, one to the 50 states and the District of Columbia to prohibit the nonemergency use of portable electronic devices for calls (H-11-39). Second, it reiterated the recommendation to the manufacturers of portable electronic devices to develop a distracted driving lock-out application. (H-20-8)

Safety Recommendations from both investigations

To the National Highway Traffic Safety Administration

Evaluate Tesla Autopilot-equipped vehicles to determine if the system's operating limitations, the foreseeability of driver misuse, and the ability to operate

[6]National Transportation Safety Board. 2020. Collision Between a Sport Utility Vehicle and Medium-Size Bus Transporting Adult Passengers with Disabilities and Special Needs, Belton, South Carolina, December 17, 2019. NTSB/HAR-21/02. https://www.ntsb.gov/investigations/AccidentReports/Reports/HAR2102.pdf

the vehicles outside the intended operational design domain pose an unreasonable risk to safety; if safety defects are identified, use applicable enforcement authority to ensure that Tesla Inc. takes corrective action. (H-20-2)

For vehicles equipped with Level 2 automation, work with SAE International to develop performance standards for driver monitoring systems that will minimize driver disengagement, prevent automation complacency, and account for foreseeable misuse of the automation. (H-20-3)

After developing the performance standards for driver monitoring systems recommended in Safety Recommendation H-20-3, require that all new passenger vehicles with Level 2 automation be equipped with a driver monitoring system that meets these standards. (H-20-4)

To Manufacturers of Portable Electronic Devices (Apple, Google, HTC, Lenovo, LG, Motorola, Nokia, Samsung, and Sony)

Develop a distracted driving lock-out mechanism or application for portable electronic devices that will automatically disable any driver-distracting functions when a vehicle is in motion, but that allows the device to be used in an emergency; install the mechanism as a default setting on all new devices and apply it to existing commercially available devices during major software updates. (H-20-8)

To the 50 States and the District of Columbia

(1) Ban the nonemergency use of portable electronic devices (other than those designed to support the driving task) for all drivers;
(2) use the National Highway Traffic Safety Administration model of high visibility enforcement to support these bans; and
(3) implement targeted communication campaigns to inform motorists of the new law and enforcement, and to warn them of the dangers associated with the nonemergency use of portable electronic devices while driving. (H-11-39)

CONCLUSION

Although the accident examples used to illustrate the nature of operator fatigue and distraction are from rail and highway, accidents resulting from fatigue and distraction occur in all modes of transportation, often with deadly results. The effects of fatigue on employee performance is a threat to the safety of employees and the riding public. Available mitigations include employers developing, using and evaluating fatigue risk management programs as part of their safety management system. Prevention of operator distraction can be approached from several angels including technology, legislation and education.

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