National Transportation Safety Board

Washington, DC 20594

Highway Accident Brief

Multivehicle Work Zone Crash on Interstate 84, Boise, Idaho, June 16, 2018

Accident Number:	HWY18FH015
Accident Type:	Multivehicle collision in work zone
Location:	Interstate 84, near milepost 47, Boise, Idaho
Date and Time:	June 16, 2018; about 11:32 p.m., mountain daylight time
Vehicle 1:	2019 Volvo truck-tractor in combination with 2015 Great Dane refrigerated semitrailer
Vehicle 2:	2008 Jeep Wrangler
Vehicle 3:	2003 Volvo truck-tractor in combination with 2008 Great Dane refrigerated semitrailer
Vehicles 4–7:	2006 Ford Fusion, 2014 Ford F-150, 2015 Ford Escape, 2010 Ford Focus
Fatalities:	4
Injuries:	4 (minor)

Crash Description

On Saturday, June 16, 2018, about 11:32 p.m., local time, a multivehicle collision occurred involving a 2019 Volvo truck-tractor in combination with a 2015 Great Dane refrigerated semitrailer, operated by Krujex Freight Transport Corporation (Krujex), which was traveling east on Interstate 84 (I-84), near Boise, Idaho (see figure 1).[1] The truck, occupied by a 42-year-old driver, had departed Yakima, Washington, and was en route to Methuen, Massachusetts, on a multiday trip.

Work zone lane closures began on eastbound I-84 ahead of the initial crash location, resulting in a traffic queue. The traffic queue extended from the beginning of the work zone back over a mile into the advance warning area for the zone, with most of the traffic in the queue either stopped or traveling at a slow speed. The driver of the 2019 Volvo combination vehicle, traveling in the third lane from the left (lane 3) did not apply brakes or otherwise respond to the traffic queue

[1] Throughout this report, this truck-tractor in combination with the semitrailer, which initiated the crash sequence, is interchangeably referred to as the "2019 Volvo truck" or the "2019 Volvo combination vehicle."

ahead.[2] His vehicle collided with the rear of a slow-moving 2008 Jeep Wrangler at milepost (MP) 47.007, near the Cloverdale Road overpass, at an estimated speed of 62 mph.[3]

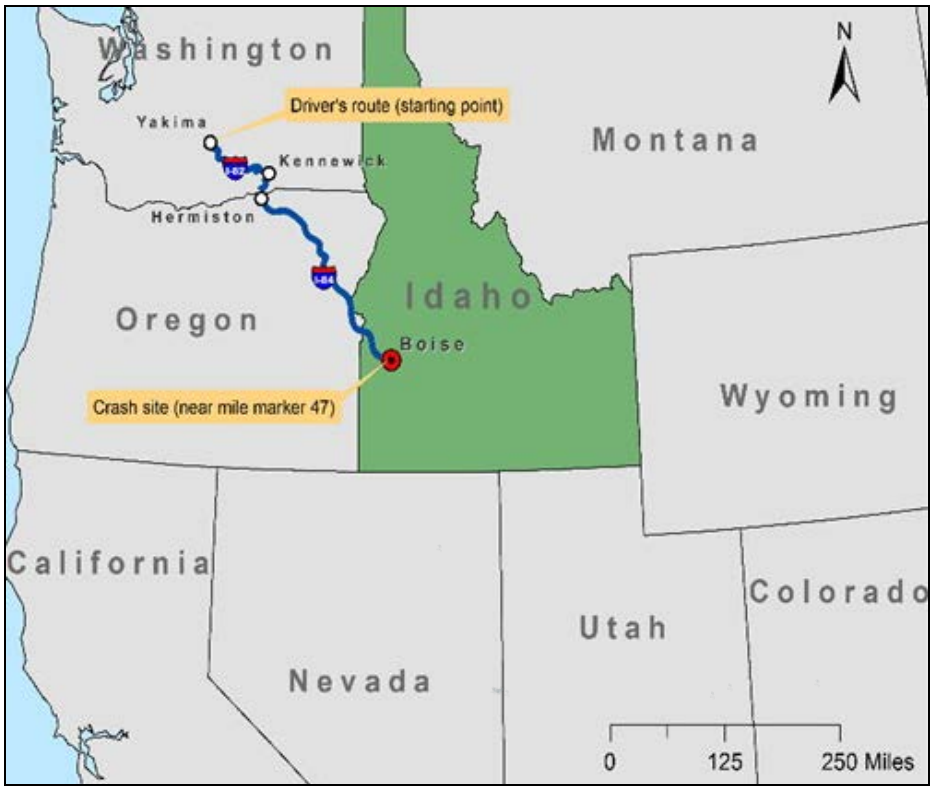

Figure 1. Map showing route of 2019 Volvo truck from origin to crash location.

After being struck by the 2019 Volvo truck, the Jeep was pushed forward so that it underrode the trailer of a 2003 Volvo truck-tractor in combination with a 2008 Great Dane refrigerated semitrailer in the same lane. The 2003 Volvo combination vehicle moved forward and collided with the rear of a 2006 Ford Fusion, pushing it into the rear of a 2014 Ford F-150 and sideswiping a 2015 Ford Escape. Debris from the collision also damaged a 2010 Ford Focus. A postcrash fire ensued that consumed the Jeep, most of the 2003 Volvo combination vehicle's semitrailer, and a portion of the 2019 Volvo truck's cab and semitrailer, as well as severely damaging the Cloverdale Road overpass.[4] Figure 2 shows a diagram of the crash area and the locations of the vehicles at final rest, and figure 3 shows the postcrash condition of the two combination vehicles and the Jeep.

[2] For the purposes of this report, the eastbound lanes are identified, in the direction of travel from left to right, as lanes 1 through 4.

[3] Normally, the speed limit at this location is 65 mph; the speed limit had been reduced to 55 mph for the work zone. The 62 mph impact speed was calculated based on an onboard video recorded by a Garmin device installed on the 2019 Volvo truck-tractor.

[4] The fire originated in the Jeep's fuel system.

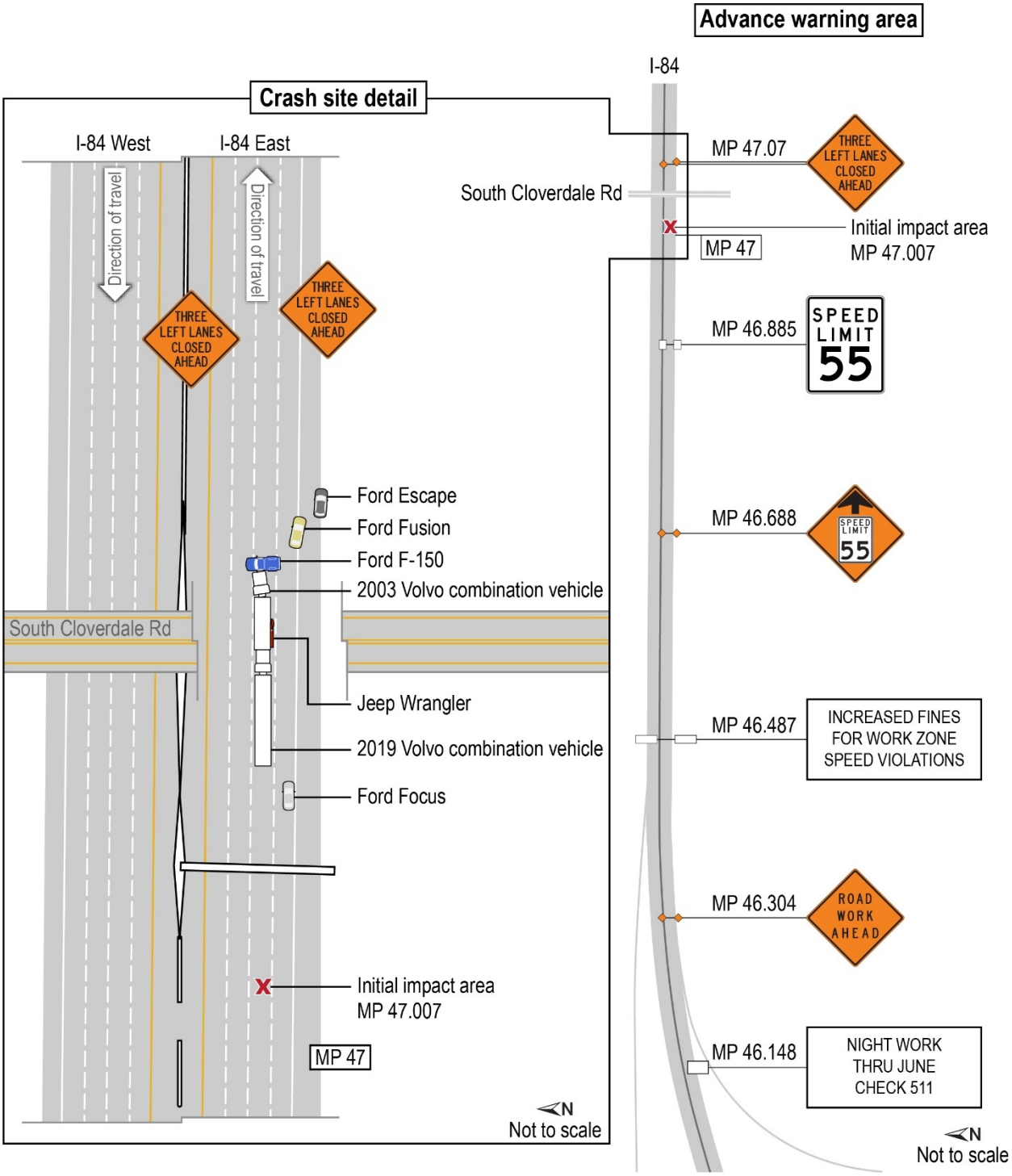

Figure 2. Diagram of crash area on I-84. The right side of the figure shows part of the advance warning area for the work zone and the locations of the signage on I-84 between MP 46.148 and slightly beyond MP 47.07. The left side of the figure is an expanded view of the immediate crash area, which is represented from MP 47 to just beyond MP 47.07.

Figure 3. Postcrash photograph of vehicles under Cloverdale Road overpass; view is looking west, toward the 2019 Volvo truck that began the crash sequence. (Source: Idaho State Police)

The Jeep was occupied by a 23-year-old male driver and two passengers. The three occupants of the Jeep died as a result of the collision and postcrash fire. The driver of the 2019 Volvo truck died as a result of the postcrash fire. The drivers of the 2003 Volvo truck, Ford F-150, Ford Escape, and Ford Focus received minor injuries. At the time of the crash, it was dark (nighttime) with clear weather and a dry road surface.

Vehicles

2019 Volvo Truck-Tractor in Combination with 2015 Great Dane Semitrailer

The 2019 Volvo truck-tractor sustained severe impact and thermal damage to all areas, which affected its major mechanical and operational systems. The impact damage was primarily located forward of the drive axles (axles 2 and 3). Most of the combustible material from the front bumper to the tail lamps was either consumed by the postcrash fire or badly damaged. The 2015 Great Dane semitrailer experienced less significant damage.

The 2019 Volvo truck-tractor was equipped with an aftermarket onboard Garmin camera system. This system recorded vehicle speed, interior audio, and forward-facing video when triggered.[5] An image taken by the onboard camera system shows the position of the Jeep 1.3 seconds before the crash impact (see figure 4). Taken from the perspective of the 2019 Volvo truck driver, the image shows the end of the traffic queue, with the Jeep in lane 3 immediately

[5] In addition to recording the video, the Garmin device recorded the global positioning system (GPS) location of the tractor, and the tractor's speed was computed based on the GPS locations.

ahead of the recording truck-tractor, and beyond it, the rear of the 2008 Great Dane refrigerated semitrailer ahead of the Jeep.[6]

Figure 4. Screenshot from Garmin forward-facing video camera on 2019 Volvo truck-tractor taken shortly before crash. (Source: Garmin Dash Cam)

Although the 2019 Volvo truck-tractor had been marketed with a collision avoidance system, the Volvo Active Driver Assist (VADA) system, as part of the standard vehicle equipment package, the purchaser requested that this truck be delivered without the VADA system, providing a purchase savings of $2,524.[7]

2008 Jeep Wrangler

The 2008 Jeep Wrangler sustained impact and thermal damage to both its front and rear, with most of the combustible materials consumed by the postcrash fire. As a result of the Jeep being pushed into the semitrailer ahead of it, the Jeep's engine was displaced rearward into the firewall and passenger compartment. The frame rails at the front of the vehicle were also displaced rearward and were distorted and bent. The intrusion into the Jeep's passenger compartment resulting from the Jeep first striking and then under-riding the trailer of the 2003 Volvo truck

[6] As the 2019 Volvo truck approached the traffic queue, a Ford pickup truck that had been ahead of the 2019 Volvo truck moved from lane 3 to lane 4, exposing the rear of the Jeep.

[7] In some circumstances, the VADA system can automatically apply braking when it identifies a vehicle ahead of the vehicle on which it is installed. Because the speed differential between the 2019 Volvo truck and the Jeep was high, and another vehicle was moving out of the Volvo truck's lane of travel immediately before the impact, the NTSB cannot definitively assess whether the VADA system could have prevented this crash. The NTSB has previously recommended that collision avoidance systems be required technology for all commercial vehicles and continues to advocate for these recommendations (see Safety Recommendations H-15-5 and -8, which are both currently classified "Open—Acceptable Response" in the NTSB Safety Recommendations database).

caused a total loss of occupant survivable space. Data from the Jeep's airbag control module indicated that the vehicle was traveling 3–4 mph moments before the 2019 Volvo struck it.

2003 Volvo Truck-Tractor in Combination with 2008 Great Dane Semitrailer

Because the 2003 Volvo truck was struck by the Jeep from the rear, its truck-tractor sustained little damage in the crash. The 2008 Great Dane refrigerated semitrailer's rear impact guard remained securely mounted, but the rear bumper rotated downward, which allowed the rear impact guard to rotate upward into the floor of the semitrailer.[8] The right and left tail lamp mounting locations in the bumper were displaced rearward and rotated upward. There was considerable thermal damage to the semitrailer, especially at the rear.

Highway Factors

In the area of the crash, I-84 is a controlled-access highway with four eastbound and four westbound lanes divided by a 32-inch-tall concrete median barrier.[9] Traveling eastbound, the median shoulder is delineated from the far left lane, lane 1, by a solid yellow pavement stripe. The far right lane, lane 4, is delineated from the right shoulder by a solid white pavement stripe.

The average daily traffic count for I-84 in 2017 was 85,270 vehicles per day; heavy-truck traffic accounted for 8.5 percent (7,280 trucks per day) of the total.

The posted speed limit for I-84 east was 65 mph; the speed limit in the work zone area had been reduced to 55 mph, beginning at MP 46.885, before the site of the initial impact at MP 47.007. When measured in 2017, the 85th percentile speed for this area was 74 mph.[10]

In the 5-year period 2012–2016, a total of 1,849 work zone crashes occurred in Idaho; 7 of those crashes resulted in fatalities.[11] The most common harmful event in the work zone crashes was a rear-end collision involving multiple vehicles. The crash history for the 6-mile-long east–west segment of I-84 centering on the crash site showed that, between July 2015 and July 2018, two other fatal crashes occurred in this area. Neither crash was related to work zone activity.

[8] Vehicle underride protection equipment may not be capable of withstanding high-energy collisions such as this one, which involved a heavy vehicle traveling at a relatively high speed.

[9] The concrete median barriers were cast in place and met the requirements of National Cooperative Highway Research Program 350 test level 4.

[10] The 85th percentile speed is the speed at, or below which, 85 percent of the vehicles are traveling. (See Highway Attachment–ITD Engineering and Traffic Investigation Study, in the docket for this investigation, HWY18FH015.)

[11] This information is from table 46 (and associated text) of *Idaho Traffic Crashes 2017*, published by the Idaho Transportation Department Office of Highway Safety. (See Highway Group Chairman's Factual Report in the docket for this investigation, HWY18FH015.)

Work Zone

General

The crash occurred in the advance warning area of an active work zone. The work zone project involved pavement repair and resealing, and it included diamond grinding of concrete pavement, resealing concrete pavement joints, repairing concrete pavement cracks, and repairing pavement spalls.[12] The work zone on I-84 extended from MP 48.32 to MP 51.30, while the advance warning area for the work zone extended from MP 46.148 to MP 48.32. The initial impact between the 2019 Volvo truck-tractor and the Jeep occurred in the advance warning area, at MP 47.007. The placement, dimensions, colors, and retro-reflectivity of the traffic control devices for the work zone and advance warning area met the specifications of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD).

Preparations for Work Zone

The Idaho Transportation Department (ITD) contracted with Penhall Company to perform the pavement repair and resealing work on I-84. ITD contracted with Parametrix, a traffic engineering firm, to develop a construction staging and traffic control plan that included special provisions requiring nighttime work and limiting lane closures. Penhall Company subcontracted with two firms: Specialty Construction Supply Company, Inc. (Specialty Construction), to perform on-site traffic control, and Diamond Drilling and Sawing, to perform some pavement repair work.

Parametrix used the *Highway Capacity Manual 2010* for its evaluations and determined that the capacity of I-84 in this area was 1,450 vehicles per lane per hour.[13] Based on these numbers, the traffic control plan required that at least two lanes remain open to traffic in either direction on four-lane sections of the highway during all phases of the work, including on the work zone ahead of the crash location. The ITD provided these special provisions and the traffic control plan to Penhall Company in the contract documents.

The special provisions detailed the process by which contractors could change the construction staging and the traffic control plan. Proposed changes required a written amended plan to be completed by an engineer licensed in Idaho. The amended plan had to be submitted for approval to ITD at least 14 days in advance of any intended changes. The special provisions stated that the existing plan would remain in place until ITD approved any proposed changes.

NTSB investigators reviewed the Parametrix construction staging and traffic control plan as originally submitted and found that the documents complied with MUTCD standards. Additionally, investigators found that the ITD preparations for the work zone complied with 23 *Code of Federal Regulations* (CFR) Part 630, Subpart J, "Work Zone Safety and Mobility."

According to Penhall Company, in a May 31, 2018, meeting with the ITD project engineer, it made a verbal request to close three (rather than two) lanes for the work zone. ITD told

[12] Diamond grinding consists of cutting grooves into pavement and grinding down damaged areas and minor cracks. Pavement spalls are typically cracking, chipping, or breaks in the pavement.

[13] The manual, which is the fifth edition of this reference work, is published by the Transportation Research Board. It provides engineers and planners with information to help them assess the traffic and environmental effects of highway projects.

investigators that this topic was discussed at the May 31 meeting, but no meeting minutes were kept. Penhall Company did not make a written request to deviate from the existing plan, and the ITD did not review or approve such a written request. The traffic control subcontractor Specialty Construction was not represented at the May 31 meeting but was later told by Penhall Company to close three lanes.

Work Zone on the Day of the Crash

On June 16, 2018, at the time of the crash, Diamond Drilling and Sawing was working on the eastbound lanes, and Penhall Company was working on the westbound lanes in the I-84 work zone. Specialty Construction was providing temporary traffic control. ITD work zone inspectors were also on the scene to oversee the project.

Despite the construction staging and traffic control plan requiring that two lanes remain open at all times during construction, lanes 1, 2, and 3 in the eastbound direction were all closed; only lane 4 (the far right lane) was open.[14] Data recorded by the ITD automatic traffic recorders that were positioned in the transition area for this work zone indicated that, before the crash, the traffic speed had slowed to about 18 mph and had resulted in a lengthy queue forming, due to the vehicle stop-and-go situation. The ITD work zone inspectors noted the lane closures in their traffic control maintenance diaries, but they did not take any action to address the fact that the lane closures exceeded those permitted by the traffic control plan or to resolve the resulting hazards associated with the traffic queue.[15]

Work Zone Summary

To summarize, the traffic control plan for the work zone on I-84 was designed to have two lanes in each direction always open to allow for safe traffic flow. Sometime before the day of the crash, the lead contractor, Penhall Company, told the traffic control subcontractor, Specialty Construction, to close three eastbound lanes, leaving only one through lane. This change in the traffic control plan was not submitted in written form to the ITD, as required by the special provisions of the construction staging and traffic control plan. Neither Specialty Construction nor any of the ITD work zone inspectors objected to this deviation from the plan, which, based on information found in work zone inspector diaries, was practiced for several days before the crash. As a result of the additional closed lane, a traffic queue formed that extended into the eastbound advance warning region of the I-84 work zone, which led to slow-moving and stopped traffic. Eastbound vehicles approaching the area encountered a traffic queue more than 1 mile long. The additional lane closure and the extension of the queue into the advance warning region resulted in inadequate warning to motorists and insufficient speed reduction for approaching traffic for this work zone.

[14] The first taper area to close lane 1 began 2,329 feet ahead of the initial crash location at MP 47.007. The distance from the impact location to where lane 1 was closed was 3,229 feet.

[15] For more information, see the Highway Group Chairman factual report in the docket for this investigation, HWY18FH015.

By merely noting, and not preventing, the contractor's deviation from the traffic control plan, the ITD work zone inspectors failed to conduct the oversight for which they had been placed on the scene in the construction area. The ITD also failed by not ensuring that its inspectors fulfilled their oversight duties.

The NTSB has previously issued safety recommendations regarding traffic queue management in work zones. For example, in 2001, in its special investigation report on rear-end collisions, the NTSB issued Safety Recommendation H-01-11 to the Federal Highway Administration (FHWA).[16] This safety recommendation led to revision of the MUTCD standards for work zone safety and mobility on December 16, 2009.[17] The MUTCD revisions included providing guidance and resources to assist states in evaluating work zone safety and determining ways to reduce risks.

More recently, as a result of its investigation of a 2014 work zone crash involving a truck striking the rear of a traffic queue in Cranbury, New Jersey, the NTSB issued Safety Recommendation H-15-16 to the FHWA.[18] Safety Recommendation H-15-16 called on the FHWA to amend the MUTCD guidance for work zone projects on freeways and expressways to advise traffic engineers on the use of supplemental traffic control strategies and devices to mitigate crash events involving heavy commercial vehicles.[19] In its response to the NTSB recommendation, the FHWA stated that it is proposing changes to the next revision of the MUTCD to address this recommendation.

Motor Carrier Operations

Krujex, the operator of the 2019 Volvo combination vehicle, began operations in 2012, entered the Federal Motor Carrier Safety Administration (FMCSA) New Entrant Program in July 2013, and exited the program after successfully completing an FMCSA safety audit on April 23, 2014.[20] The FMCSA did not conduct a compliance review of Krujex before the crash. Based on its roadside inspection data, before the crash, Krujex's driver out-of-service rate was 16.7 percent, which was above the national average of 5.5 percent.[21]

[16] See *Vehicle- and Infrastructure-Based Technology for the Prevention of Rear-End Collisions*, Special Investigation Report NTSB/SIR-01/01 at SIR0101.

[17] Safety Recommendation H-01-11 was classified "Closed—Acceptable Alternate Action" in 2010.

[18] For more information, see *Multivehicle Work Zone Crash on Interstate 95, Cranbury, New Jersey, June 7, 2014*, Highway Accident Report NTSB/HAR-15/02 at HAR1502.

[19] Safety Recommendation H-15-16 is currently classified "Open—Acceptable Response."

[20] This program consists of a maximum 18-month-long safety-monitoring period for new entrant carriers. During this period, the FMCSA conducts a safety audit of the carrier and evaluates its crash and roadside inspection data. According to the FMCSA, the safety audit should cover the following areas: driver qualifications, driver duty status, vehicle maintenance, accident register, and controlled substance and alcohol use testing requirements. If the FMCSA identifies deficiencies during the audit, the carrier must provide evidence that it is correcting the faults.

[21] This driver out-of-service rate was below the threshold to trigger an alert in the Federal Motor Carrier Census to quantify performance in the Behavior Analysis and Safety Improvement Categories (BASICs). See additional information at the FMCSA SAFER website.

The FMCSA conducted a postcrash comprehensive compliance review of Krujex and, on July 19, 2018, gave the carrier an unsatisfactory rating due to violations.[22] On August 21, 2018, the carrier submitted a request for, and was granted, an upgrade to a conditional rating after providing a corrective action plan to the FMCSA. As of the date of this report, Krujex's status remains conditional.

2019 Volvo Truck Driver

Driving Experience and Medical Information

At the time of the crash, the 42-year-old truck driver had a class A commercial driver's license that had been issued by the state of New York in August 2017. The license showed no restrictions, and the driver had endorsements for hauling double and triple trailers.

The driver had been operating commercial vehicles since 2009 and was hired by Krujex in May 2018. He had previously worked as a driver for motor carriers (including Krujex) transporting fruit from the Pacific Northwest to eastern destinations; he was familiar with this route and had completed many similar trips.

A review of the driver's record in the Commercial Driver's License Information System (CDLIS) showed numerous convictions for 2009–2016 and several license withdrawals from 2009 to 2017. The driver had been subject to two license withdrawals from New York: one beginning on February 1, 2017, and the other on April 3, 2017. Both were reinstated on August 2, 2017. These withdrawals were for having two and three serious violations within 3 years, respectively. The CDLIS indicated no previous crashes for the driver. FMCSA data showed a November 14, 2014, crash for this driver on I-84 in Idaho involving a multivehicle collision during icy road conditions. The Idaho State Police did not find him at fault.

The driver's most recent commercial driver fitness determination medical examination had taken place in December 2016. He received an unrestricted medical certificate for 2 years.

A postcrash toxicology sample taken from the driver was negative for alcohol and other drugs.[23]

Hours of Service

The truck driver was required to maintain a record-of-duty status, including hours of service, via an electronic logging device (ELD).[24] Krujex management told NTSB investigators that the driver had told them that the ELD for the 2019 Volvo truck was not functioning;

[22] Violations included the following: using drivers who have not completed an application; failing to conduct driver record inquires; failing to maintain a copy of the driver's medical certificate; not requiring electronic logging device usage; making false report of duty status; failing to preserve driver's record-of-duty status for 6 months; and lacking appropriate alcohol and controlled substance testing, record maintenance, and provision of education materials.

[23] The analysis for drugs included, but was not limited to, barbiturates, benzodiazepines, cannabinoids, cocaine metabolites, methamphetamine, opiates, and phencyclidine.

[24] An ELD is a device or technology that automatically records a driver's driving time, facilitates the accurate recording of the driver's hours of service, and meets the requirements set forth in subpart B of 49 CFR 395.2.

consequently, the driver had been filling out paper logbook forms.[25] Investigators recovered and examined two paper logbooks from the remains of the 2019 Volvo truck. The first logbook covered June 8–16, 2018, with off-duty entries for June 8–14, 2018. For June 15, the driver recorded being off duty until 8:30 p.m., on duty but not driving until 9:00 p.m., and then driving from 9:00 p.m. until 12:00 a.m. The logbook also recorded driving time on June 16 from 12:00 a.m. until 1:00 a.m., off-duty time in the sleeper berth until 2:00 p.m., and driving time until 7:00 p.m. The second logbook documented a period from May 27 through June 11, 2018, with entries for 11 hours of driving on June 9 and 10, as well as 4 hours of driving on June 11.

NTSB investigators obtained data from Tec Equipment, the company that leased the 2019 Volvo truck to Krujex, for the ELD installed in the vehicle. The data showed that the ELD was functional at the time of the crash. The data from the ELD were not consistent with the 2019 Volvo truck driver's paper logbook entries.

According to the ELD data, on June 15, the day before the crash, the driver began driving at 5:54 a.m. and drove for various intervals of time until 1:00 a.m. on June 16. The ELD data showed that the vehicle was stationary from 1:00 a.m. until 7:15 a.m. on June 16. According to the ELD data and bills of lading, after having the truck loaded with apples in Yakima, Washington, the driver began his eastbound trip at 7:15 a.m. on June 16.[26] The driver drove a series of relatively short segments (ranging in length from 15 minutes to 3.5 hours) as he headed to Boise, Idaho, on this leg of his cross-country journey to Massachusetts. During the trip on June 16, the driver stopped the vehicle several times, with the ELD recording non-moving periods that were 2.5 hours long or less, and he continued driving until the crash at 10:32 p.m.[27] The distance from where the truck was loaded to the crash scene was about 360 miles. Figure 5 shows the ELD data, indicating when the 2019 Volvo truck was moving and when it was stopped.

[25] Title 49 CFR 395.34(a) addresses "Recordkeeping during ELD malfunctions." The use of paper logbook forms is not permitted under the CFR requirements. A carrier must have special permission from the FMCSA to use paper logbooks if an ELD is nonfunctional. Krujex had not requested and did not have such permission.

[26] The FMCSA provides carriers an hours-of-service exemption when transporting agricultural products. Current FMCSA interpretations allow a driver an hours-of-service exemption when traveling to and from the source of agricultural products, defines what is considered "the source," and clarifies that drivers may use the exemption during the first 150 air miles (172 statute or "road" miles) of a trip that delivers outside of the 150-air-mile radius. Investigators asked the owner of Krujex about his knowledge of the agricultural exemption. He said that he was not aware of this FMCSA guidance and did not know what it allowed. He said that he was not aware that his operation was permitted under the exemption.

[27] The times given in this paragraph and the next, as well as in figure 5, are in Pacific daylight time, based on the driver's starting point of Yakima, Washington, in the Pacific time zone. The crash, however, occurred in Boise, which is in the mountain time zone. Consequently, the crash time in this paragraph and the chart is represented as 1 hour earlier than the corresponding crash time in mountain daylight time.

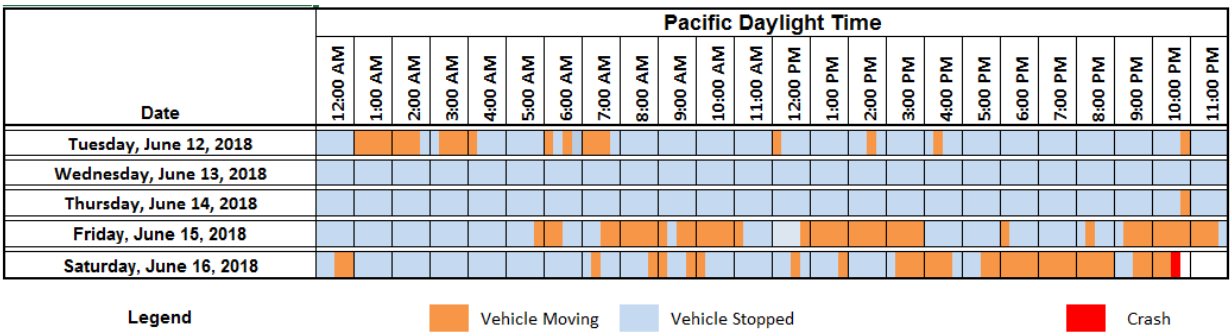

Figure 5. ELD data for the 5 days preceding the crash, showing when the 2019 Volvo truck was moving and stopped. (Note: The trip began in Yakima, Washington, which is in the Pacific time zone, but the crash occurred in Boise, Idaho, which is in the mountain time zone. The crash time of 10:32 p.m. Pacific daylight time used in figure 5 corresponds to the crash time of 11:32 p.m. mountain daylight time.)

Investigators were unable to obtain complete information about the truck driver's sleep/wake history preceding the crash, including information from his cell phone. However, based on the ELD data, in the 48-hour period before the crash, the longest opportunities the driver had for rest were two 6-hour-long segments: one from about 11:30 p.m. on June 14 to 5:45 a.m. on June 15 and another from about 1:00 a.m. to 7:15 a.m. on June 16. The remaining periods during which the truck was stationary were fragmented into short increments with insufficient time to have provided the driver opportunity for restful sleep.[28]

Precrash Actions

Video segments from the Garmin unit installed in the 2019 Volvo truck showed numerous instances preceding the crash where the driver allowed the truck to drift from its lane (both onto the shoulder and into other lanes) and to straddle the painted lane markings.[29] Specifically, between 11:15 p.m. and the crash, the Garmin unit recorded the following movements by the 2019 Volvo truck:[30]

- **11:15:00**—During the next 2 minutes 30 seconds, while traveling in lane 4, the truck drifted onto the shoulder and was corrected back into lane 4 about 10 times.
- **11:17:40**—The truck continued to drift from lane 4 to the shoulder and back again, while traveling 60–65 mph. Over the next 1 minute 30 seconds, the truck drifted onto the shoulder about 5 times.
- **11:23:49**—While traveling in lane 3, the truck began to drift into lane 4.
- **11:24:56**—During the next 1 minute 30 seconds, the truck made three incursions from lane 4 onto the right shoulder.

[28] See J.J. Pilcher and A.I. Huffcutt. 1996. "Effects of Sleep Deprivation on Performance: A Meta-Analysis." *Sleep* 19(4): 318–326.

[29] For more information, see the Onboard Image Recorder Group Chairman factual report in the docket for this investigation, HWY18FH015.

[30] Times in this section are in mountain daylight time.

- **11:26:00**—From lane 4, the truck drifted to the left and entered lane 3.
- **11:26:50**—The truck drifted from lane 4 onto the shoulder and then returned to lane 4.
- **11:27:47**—The truck drifted to the left and straddled lanes 2 and 3 before returning to lane 3.

Summary of Fatigue Indications

Based on the ELD recording of the movements of the 2019 Volvo truck, the driver had limited chances for rest preceding the crash. His lengthy on-duty hours in the 2 days before the crash, and the relatively short windows of opportunity for sleep, indicate that he most likely did not obtain adequate sleep during this period. The crash occurred at night when people are more disposed to exhibit fatigue.[31] Moreover, the driver's inability to maintain his vehicle's lane position, as well as his complete lack of response to the traffic queue as he came upon it, are consistent with a fatigue-related lapse in vigilance.[32]

Probable Cause

The National Transportation Safety Board determines that the probable cause of the Boise, Idaho, crash was the Krujex Freight Transport Corporation driver's failure to respond to the slow-moving traffic queue ahead, most likely due to performance decrements associated with fatigue. Contributing to the crash were the (1) inadequate traffic control and queue management procedures employed by Penhall Company and its subcontractor Specialty Construction Supply Company, Inc., and (2) lack of proper oversight by the Idaho Transportation Department, which allowed an additional lane closure that was not part of the approved traffic control plan, resulting in a traffic queue that extended into the advance warning area of the work zone.

Report Date: June 11, 2020

For more details about this crash, visit the NTSB public docket and search for NTSB accident ID HWY18FH015. The docket includes such information as police reports, photographs, manuals, and interview transcripts.

[31] The driver was a New York resident, and the time difference between New York and Idaho may have compounded his fatigue.

[32] See R.R. Knipling and J. Wang. 1994. "Crashes and Fatalities Related to Driver Drowsiness/Fatigue." *Research Note*. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations*, Section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code*, Section 1154[b]).