Agricultural Labor Bus and Truck-Tractor Collision at US-98–SR-363 Intersection Near St. Marks, Florida July 2, 2016

Accident Report

NTSB/HAR-17/05
PB2018-100307

National Transportation Safety Board

NTSB/HAR-17/05
PB2018-100307
Notation 57233
Adopted November 28, 2017

Highway Accident Report

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at US-98–SR-363 Intersection
Near St. Marks, Florida
July 2, 2016

National
Transportation
Safety Board

490 L’Enfant Plaza SW
Washington, DC 20594

National Transportation Safety Board. 2017. *Agricultural Labor Bus and Truck-Tractor Collision at US-98–SR-363 Intersection Near St. Marks, Florida, July 2, 2016*. Highway Accident Report NTSB/HAR-17/05. Washington, DC.

Abstract: On Saturday, July 2, 2016, about 5:16 a.m., a 1979 Blue Bird bus, operated by Billy R. Evans Harvesting, Inc., of Belle Glade, Florida, was traveling south on State Road 363, near St. Marks, Florida, when it was struck by a westbound 2005 Freightliner truck-tractor semitrailer at the US Highway 98 (US-98) intersection. The bus driver had failed to stop at the intersection, where traffic was controlled by a stop sign and overhead flashing red traffic control beacons. Overhead flashing yellow traffic control beacons controlled traffic on US-98. The truck-tractor struck the left side of the bus, resulting in the rapid counterclockwise rotation of the truck-tractor and the breach of its right-side-mounted diesel fuel tank, which ignited a fire. The front of the semitrailer then struck the left side of the bus. The bus was occupied by the driver and 33 passengers, most of whom were migrant agricultural (AG) workers. The truck-tractor—operated by Verity Van Lines, Inc., of Seaford, New York—was occupied by the driver and a passenger. The truck driver and three bus passengers died. The bus driver, 28 bus passengers, and a passenger in the sleeper berth of the truck were injured. The crash investigation focused on the following safety issues: transportation of AG workers, intersection safety, heavy truck fuel tank integrity, and occupant protection. The NTSB made new safety recommendations to the US Department of Labor; the Federal Motor Carrier Safety Administration (FMCSA); the National Highway Traffic Safety Administration; the Florida Department of Transportation; SAE International; nine highway, municipal, safety, and engineering associations; the American Bus Association; and the United Motorcoach Association. The NTSB also reiterated one recommendation to the FMCSA and one to the state of Florida, and reiterated and reclassified one recommendation to the FMCSA.

For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident number HWY16MH019. Recent publications are available in their entirety at the NTSB website. Other information about publications may be obtained from the website or by contacting: **National Transportation Safety Board, Records Management Division, CIO-40, 490 L'Enfant Plaza SW, Washington, DC 20594, (800) 877-6799 or (202) 314-6551**

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Acronyms and Abbreviations

AAMVA	American Association of Motor Vehicle Administrators
AASHTO	American Association of State Highway and Transportation Officials
ABA	American Bus Association
ABS	antilock brake system
ADT	average daily traffic
AG	agricultural
AITS	agricultural industries transportation services [California]
BASIC	behavior analysis and safety improvement category [FMCSA]
CDL	commercial driver's license
CDLIS	commercial driver's license information system [AAMVA]
CFR	*Code of Federal Regulations*
CHP	California Highway Patrol
CMF	crash modification factors [FHWA]
CMV	commercial motor vehicle
CSA	Compliance, Safety, Accountability program [FMCSA]
CSMS	carrier safety measurement system [FMCSA]
CR	compliance review
DBPR	Department of Business and Professional Regulation [Florida]
DOL	US Department of Labor
DOT	US Department of Transportation
ECM	electronic control module
FAA	Federal Aviation Administration
FDOT	Florida Department of Transportation
FHP	Florida Highway Patrol
FHWA	Federal Highway Administration
FLC	farm labor contractor

FLV	farm labor vehicle
FMCSA	Federal Motor Carrier Safety Administration
FMCSRs	*Federal Motor Carrier Safety Regulations*
g/dL	gram per deciliter
GCWR	gross combination weight rating
GHSA	Governors Highway Safety Association
GVWR	gross vehicle weight rating
HOS	hours-of-service
I-10	Interstate 10
I-40	Interstate 40
I-95	Interstate 95
ICWS	intersection conflict warning system
ITE	Institute of Transportation Engineers
KCAPTA	Kings County Area Public Transit Agency [California]
LCEMS	Leon County Emergency Medical Services
LCSO	Leon County Sheriff's Office
MCSAP	Motor Carrier Safety Assistance Program
MCS-150	motor carrier identification report [FMCSA form]
MSP	Michigan State Police
MSPA	Migrant and Seasonal Agricultural Worker Protection Act
MUTCD	*Manual on Uniform Traffic Control Devices for Streets and Highways*
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
OOS	out-of-service
PDO	property damage only
SAFE	safety and farm education program [CHP]
SR-78	State Road 78

SR-363	State Road 363
TFD	Tallahassee Fire Department
TFI	tapered frame integrated
TTI	Texas A&M Transportation Institute
UIIG	*Unsignalized Intersection Improvement Guide*
US-27	US Highway 27
US-98	US Highway 98
UMA	United Motorcoach Association
USC	*United States Code*
USDOT	US Department of Transportation [motor carrier number]
WCEMS	Wakulla County Emergency Medical Services
WCFD	Wakulla County Fire Department
WCSO	Wakulla County Sheriff's Office
WHD	Wage and Hour Division [DOL]

Executive Summary

Investigation Synopsis

On Saturday, July 2, 2016, about 5:16 a.m., a 1979 Blue Bird bus, operated by Billy R. Evans Harvesting, Inc., of Belle Glade, Florida, was traveling south on State Road 363 (SR-363), near St. Marks, Florida. The bus was occupied by a 56-year-old driver and 33 passengers, most of whom were migrant agricultural (AG) workers. As the bus driver approached the US Highway 98 (US-98) intersection, he did not stop at the stop sign and overhead flashing red traffic control beacons, entered the intersection, and was struck by a westbound 2005 Freightliner truck-tractor in combination with an enclosed semitrailer. The truck-tractor—occupied by a 55-year-old driver and a passenger—was operated by Verity Van Lines, Inc., of Seaford, New York. Overhead flashing yellow traffic control beacons controlled westbound traffic on US-98 at the intersection.

The front of the truck-tractor struck the left side of the bus slightly behind its front axle, resulting in the rapid counterclockwise rotation of the truck-tractor and the breach of its right-side-mounted diesel fuel tank—which ignited a fire. The front of the semitrailer then struck the left side of the bus near its rear wheel area as both vehicles proceeded toward the southwest corner of the intersection. Prior to coming to rest, the vehicles collided with fixed roadside objects, including a utility pole and its supporting cables. As a result of the crash, the truck driver and three bus passengers died. The bus driver, 28 bus passengers, and a passenger in the sleeper berth of the truck sustained injuries of varying degrees.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the St. Marks, Florida, crash was the bus driver's failure to stop at the intersection due to inattention, likely caused by the effects of fatigue; and his unfamiliarity with the rural roadway, which was dark with limited lighting. Contributing to the crash were the failure of Billy R. Evans Harvesting, Inc., to exercise adequate safety oversight of the bus driver and the lack of effective oversight of the motor carrier by the Federal Motor Carrier Safety Administration and the US Department of Labor. Contributing to the severity of the injuries were the rupture of the truck's right-side-mounted diesel fuel tank, leading to a fast-spreading postcrash fire; and the failure of the truck driver to wear his lap/shoulder belt.

Safety Issues

This crash investigation—along with supporting NTSB investigations in Little Rock, Arkansas, and Ruther Glen, Virginia—identified the following safety issues:

- ***AG worker transportation safety:*** Although many federal and state regulations require the safe transportation of AG workers, motor carriers and farm labor contractors often transport workers in unsafe vehicles and without properly qualified and rested drivers. Federal and state agencies have been ineffective in deterring unsafe operations.

- ***Intersection safety:*** The crash occurred during a repaving project. Although the roadway had been resurfaced, milled, and repainted, the raised transverse rumble strips located in advance of the intersection had not yet been reinstalled. Although the Florida Department of Transportation had improved the safety of the US-98–SR-363 intersection prior to the crash, it was not using the full complement of intersection safety treatments available.

- ***Heavy truck fuel tank integrity:*** The truck-tractor's right-side-mounted fuel tank was compromised during the collision sequence, and a postcrash fire ensued. The location of the tank beneath the truck cab and outside the frame rail made it vulnerable to impact forces and structural failure. Additionally, the lack of protective shielding and the tank's aluminum construction increased its susceptibility to being breached.

- ***Occupant protection:*** Because the truck driver was unrestrained during the collision sequence, he sustained impact injuries that prevented him from exiting the vehicle before it was consumed by the postcrash fire. Proper use of the available lap/shoulder belt would have mitigated the impact forces he experienced and likely reduced his level of injury.

Recommendations

The NTSB makes new safety recommendations to the US Department of Labor, Federal Motor Carrier Safety Administration (FMCSA), National Highway Traffic Safety Administration, Florida Department of Transportation, SAE International, American Association of State Highway and Transportation Officials, National Association of Counties, National Association of County Engineers, National League of Cities, National Association of Towns and Townships, Institute of Transportation Engineers, American Traffic Safety Services Association, American Society of Highway Engineers, American Society of Civil Engineers, American Bus Association, and United Motorcoach Association. The NTSB also reiterates one safety recommendation to the FMCSA and one to the state of Florida, and reiterates and reclassifies one recommendation to the FMCSA.

1 Factual Information

1.1 Crash Narrative

1.1.1 Precrash Events

About 3:30 a.m. on Saturday, July 2, 2016, a 1979 Blue Bird 83-passenger bus departed Bainbridge, Georgia, with a 56-year-old driver and 33 passengers, most of whom were migrant agricultural (AG) workers.[1] The group was returning to Belle Glade, Florida, after a month of harvesting corn at a farm in Camilla, Georgia.[2] Billy R. Evans Harvesting, Inc., based in Belle Glade, was the bus operator and farm labor contractor (FLC).[3] Having worked at Billy R. Evans for less than 3 months, the bus driver had never made the return trip from Bainbridge to Belle Glade. According to the driver and his supervisor, the plan was to take US Highway 27 (US-27) south from Bainbridge to the Tallahassee, Florida, area, where he would merge onto Interstate 10 (I-10) east.

According to the bus driver, he used his cell phone to navigate during the first part of the trip but discontinued using it prior to reaching the I-10 interchange.[4] However, he missed the exit for I-10 and continued on US-27 south into downtown Tallahassee (see figure 1).[5]

[1] (a) Twenty-eight injured passengers were identified following the crash. The bus driver and witnesses estimated that 50 passengers had been on the bus—it is possible that some of them left the scene postcrash. (b) Per 29 *Code of Federal Regulations* (*CFR*) 500.20, a migrant AG worker is an individual employed in seasonal or other temporary agricultural work, who is required to be absent overnight from his permanent place of residence.

[2] The corn fields in Camilla are located 15 miles from the temporary housing in Bainbridge.

[3] As the FLC, Billy R. Evans was responsible for recruiting and hiring AG workers, arranging transportation to the farm location, and coordinating housing accommodations.

[4] The bus driver stated that his phone was mounted on the dashboard of the bus and that he discontinued using it to navigate before reaching I-10, because the roadway was very dark and he wanted to concentrate on his driving.

[5] The bus driver stated in a postcrash interview that he was not concerned about missing the I-10 exit, because he believed that if he continued on State Road 363 (SR-363) south he would eventually reach "95," which he could take to his destination. However, SR-363 does not intersect with any major interstate—it terminates at a T-intersection south of St. Marks.

Figure 1. Map showing bus driver's intended and actual routes of travel.

The urban environment of Tallahassee provided substantial artificial lighting as the bus passed through more than 20 signalized intersections. Outside of Tallahassee, the highway transitions to State Road 363 (SR-363), a two-lane rural roadway with no overhead lighting. During the final 10 miles on approach to the US Highway 98 (US-98) intersection, the roadway is predominantly flat, straight, and lined on both sides with trees. According to the bus driver, he had his high beams on, which he dimmed for oncoming vehicles. He stated that he was traveling about 50 mph because the roadway was "very dark," and he was unfamiliar with the area.[6] A stop

[6] The posted speed limit on SR-363 is 55 mph until about 725 feet from the intersection with US-98, where it changes to 45 mph.

sign and two horizontally aligned overhead flashing red traffic control beacons are located at the US-98–SR-363 intersection.[7]

About 5:16 a.m., a 2005 Freightliner truck-tractor in combination with an enclosed semitrailer—occupied by a 55-year-old driver and a passenger resting in the sleeper berth—was traveling west on US-98 approaching the intersection with SR-363. The truck-tractor, operated by Verity Van Lines, Inc., of Seaford, New York, was transporting household goods. It had departed Madison, Florida, at 4:10 a.m. and was en route to St. James Island, Florida. Two horizontally aligned overhead flashing yellow traffic control beacons on US-98 alert drivers to use caution when proceeding through the intersection.[8]

1.1.2 Crash Sequence

A gas station security camera, located in the southeast corner of the US-98–SR-363 intersection, recorded both vehicles shortly before impact and portions of the collision sequence. National Transportation Safety Board (NTSB) investigators analyzed the video to estimate the speed of each vehicle just prior to impact: 46 ±2 mph for the bus and 44 ±4 mph for the truck-tractor.[9] Figure 2 shows the location of the security camera, the direction of travel for each vehicle, sight lines, and the vehicle positions of rest.

[7] Florida statute 316.076(1)(a) states that when a red lens is illuminated with rapid intermittent flashes, drivers of vehicles must stop at a clearly marked stop line. This intersection was the first flashing red beacon (stop-controlled intersection) the bus driver encountered during his 58-mile trip from Bainbridge.

[8] Florida statute 316.076(1)(b) states that when a yellow lens is illuminated with rapid intermittent flashes, drivers may proceed through the intersection or past such signal only with caution.

[9] See section 2.2.1 for additional information on the video evidence and speed estimates.

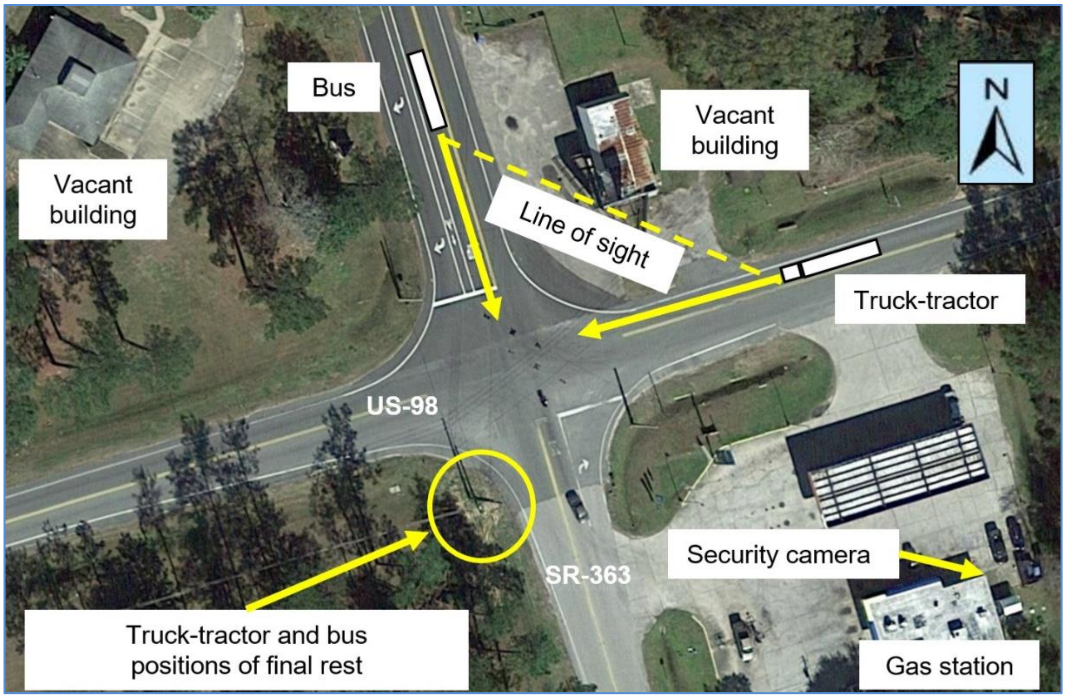

Figure 2. Aerial view of US-98–SR-363 intersection, showing approach path of each vehicle, security camera location, and vehicle positions of final rest. (Source: Google Earth image dated December 2015)

The security video showed the bus travel through the intersection without stopping and proceed directly into the path of the truck-tractor. During the crash sequence, the front of the truck-tractor struck the left side of the bus, slightly behind its front axle, which resulted in the rapid counterclockwise rotation of the truck-tractor and the breach of its right-side-mounted diesel fuel tank. Figure 3 is a still image from the security camera video depicting an explosion of fire from the truck-tractor less than 1 second after impact.

Figure 3. Still image from gas station security camera video (looking northwest), showing explosion of fire from truck-tractor and partial view of intersection.

The semitrailer continued forward and struck the left side of the bus near its rear axle. Both vehicles then proceeded in a southwesterly direction, where they collided with fixed roadside objects, including a power pole, utility boxes, and supporting guy wires.[10] Figure 4 shows the bus and truck-tractor at their positions of final rest.

Figure 4. Accident vehicles at positions of final rest at southwest corner of US-98–SR-363 intersection. (Source: Florida Highway Patrol)

[10] A guy wire is a tensioned cable designed to add stability to a free-standing structure (such as a utility pole).

1.1.3 Bus Driver Statements

Both Florida Highway Patrol (FHP) and NTSB investigators interviewed the bus driver. He told FHP investigators that he did not remember any intersection features and did not see the stop sign or any flashing signal lights.[11] His first awareness of the crash was when he "heard a big bang." He added that there were no mechanical problems with the bus and he "didn't hit the brakes at all." The FHP interview was conducted at 12:34 p.m. on July 2, 2016, about 7 hours postcrash.

In the bus driver's interview with NTSB investigators—conducted on July 10, 2016—he stated that he saw flashing lights and was preparing to slow the bus, but the brakes would not respond. He further said that he applied the brakes a total of three times on approach to the intersection, turned the steering wheel to the right when he entered the intersection and saw the truck, noticed that the truck also turned a little before the collision, and then heard a bang and lost consciousness. The bus driver said that he could not recall the color of the flashing lights, did not see a stop sign, and believed the speed limit was 55 mph.

1.2 Injuries

As shown in table 1, the truck driver and three bus passengers died; 14 bus passengers sustained serious injuries; and the truck passenger (who had been asleep in the sleeper berth), the bus driver, and 14 bus passengers received minor injuries.[12]

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[11] The bus driver did not mention seeing the "STOP AHEAD" sign during his interviews with the FHP and NTSB investigators.

[12] The truck passenger was hired as a "lumper," a term used in the trucking industry for someone who helps load and unload cargo.

Table 1. Injury levels for truck and bus occupants.

Injury Severity[a]	Fatal	Serious	Minor	Unknown	TOTAL
Truck-tractor semitrailer					
Driver	1	0	0	0	1
Passenger	0	0	1	0	1
Bus					
Driver	0	0	1	0	1
Passengers	3	14	14	2	33
TOTAL	**4**	**14**	**16**	**2**	**36**

[a] Although 49 *CFR* Part 830 pertains only to the reporting of aircraft accidents and incidents to the NTSB, section 830.2 defines fatal injury as any injury that results in death within 30 days of the accident, and serious injury as any injury that: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date of injury; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.

1.2.1 Bus Occupants

Because of insufficient passenger information, it was not possible to develop a seating chart showing the precrash positions of the bus occupants. The bus was equipped with 14 rows of seats on each side and was capable of transporting 83 passengers, assuming that three passengers occupy each seat. However, in this case, it is likely that only two adults occupied a single seat.[13]

First responders estimated that they removed 14–18 of the most seriously injured bus passengers. Wakulla County Sheriff's Office (WCSO) deputies reported finding at least 10 injured passengers trapped between seats in the rear intrusion zone. Additionally, three passengers were trapped in the front-loading stairwell under the collapsed loading door. All ambulatory bus occupants exited through the rear emergency door.

Of the fatally injured bus passengers: (1) a 47-year-old male was found near the rear emergency exit door (cause of death, blunt force trauma); (2) a 68-year-old female was found lying over the seatback in row 3 (cause of death, multiple blunt force injuries to chest and abdomen); and (3) a 4-year-old male was found near the front-loading stairwell area (cause of death, blunt force trauma to head).[14]

[13] The bus was originally designed as a school bus for the transportation of school age children. Each seat row was designed to hold three child-size passengers on each side, except for the 14th row on the driver side—which was a two-person seat.

[14] A mother, father, and their 4-year-old son had requested a ride on the bus to Belle Glade; they were not part of the migrant worker group.

Based on medical records, the serious injuries included left side rib fractures, left side lung contusions, left femur fractures, left elbow fractures, cervical and thoracic spine fractures, facial fractures, and left pelvic area fractures. Those bus passengers with minor injuries sustained lacerations and abrasions, as well as contusions to torso, head, and extremities.

1.2.2 Truck-Tractor Occupants

Following the crash, the 55-year-old driver was found in the burned remains of the truck-tractor. The surviving 21-year-old male passenger, who had been resting in the lower bed of the sleeper berth, said that he was thrown out of the bunk and onto the floor. He immediately climbed into the cab and had difficulty breathing due to smoke. The passenger reported that the entire front and passenger side of the truck-tractor were already aflame. When he saw the truck driver in the passenger seat bleeding and unresponsive, he said he attempted to lift him but described him as dead weight. The passenger then kicked open the driver door because the latch was not working. He reported falling to the ground and injuring his head.[15] He then ran to the gas station on the southeast corner of the intersection and asked bystanders to call 9-1-1. According to the autopsy report, the truck driver died as the result of blunt force and thermal trauma.[16] The truck passenger sustained minor injuries.

1.2.3 Occupant Restraints

The bus was equipped with a lap-only belt at the driver position. It was not equipped with passenger seat belts. Although the lap belt assembly could not be examined due to the extensive postcrash fire damage, the bus driver stated that he was wearing his seat belt and was not thrown out of his seat during the collision sequence.

The truck-tractor was equipped with a lap/shoulder belt at the driver and the front passenger seating positions. The sleeper berth had no restraint system. During postcrash examination of the truck, the driver seat belt buckle was attached to the seat frame at the right side of the seat with no latch plate in the buckle.[17] The passenger reported that he had found the truck driver unbelted and in the passenger seat after the crash.

1.3 Emergency Response

Appendix B presents a timeline of the emergency communications and response, beginning with the initial notification call at 5:18 a.m. and ending with transportation of the injured to local hospitals. An off-duty volunteer Wakulla County firefighter witnessed the crash and used his county-owned radio to notify WCSO.

Emergency responders arrived at the crash scene within 7 minutes. A multiagency response consisted of resources from the FHP, WCSO, Wakulla County Fire Department (WCFD), Wakulla County Emergency Medical Services (WCEMS), Leon County Sheriff's

[15] Security video footage shows the driver door of the cab opening about 25 seconds after the truck-tractor came to rest alongside a utility pole at the southwest corner of the intersection.

[16] The degree of thermal damage to the body prevented the identification of any specific blunt force injuries.

[17] When a belt is worn, the metal latch plate snaps into the buckle assembly.

Office (LCSO), and Tallahassee Fire Department (TFD). A unified command post and triage area was set up in the parking lot of a vacant building. The WCFD assumed overall incident command and assigned a TFD battalion chief to handle fire operations and hazmat. The WCEMS handled the majority of transportation to Tallahassee area hospitals.

The extrication of three bus passengers was delayed due to concern over downed and low-hanging utility lines where the vehicles came to final rest. Difficulties communicating with and waiting for the local electrical company, Duke Energy, further delayed the extrication process.[18] Under normal circumstances, Duke Energy could have remotely de-energized the utilities in the area, but one of the accident vehicles struck the junction box, making it nonoperational.[19] Once Duke Energy representatives arrived on scene, they determined that the downed lines were communication lines and not a safety threat to first responders.[20]

1.4 Vehicles

1.4.1 Bus

1.4.1.1 Damage. The 1979 Blue Bird bus had 14 rows of seats and was originally placed in service for school transportation. After the bus was retired from school bus use, it was used for the transportation of migrant AG workers.[21] As shown in figure 5, the collision damage was concentrated on the left side of the bus in the vicinity of rows 2 and 3 (maximum crush of 22 inches) and near rows 11–14 (maximum crush of 34 inches), and at the right front corner of the bus near the loading door. Many of the seats, seat pan frames, and anchors in the left intrusion areas were deformed and displaced inward. The fire had damaged all areas of the bus. NTSB investigators were unable to measure individual axle weights or the depths of exterior impacts because of the fire damage.[22] Investigators mapped the bus to create a three-dimensional model (see right image in figure 5) from which scaled measurements were taken.

[18] Duke Energy representatives arrived on scene about 1.5 hours postcrash, after the WCFD and WCSO had removed injured passengers from the bus.

[19] Security camera footage showed a large explosion as the truck-tractor and the bus reached the southwest corner of the intersection in the vicinity of the utility boxes.

[20] At a postcrash meeting in mid-July, it was determined that Duke Energy would train WCFD personnel on how to distinguish energized utility lines from communication lines.

[21] According to the Florida Department of Highway Safety and Motor Vehicles website, the bus had been registered to Billy R. Evans Harvesting, Inc., since August 2009.

[22] The total estimated weight of the bus—including driver, passengers, cargo, and fuel—was 27,270 pounds.

Figure 5. Deformation to front-loading door area and left side of bus.

1.4.1.2 Mechanical Systems. The collision and postcrash fire damage precluded a complete functional inspection of the air and braking components. Functional checks of the individual brakes were completed by supplying compressed air directly to three of the four brake chambers.[23] All of the brakes tested were within acceptable adjustment limits. Moreover, all of the brake pads were found to be in excess of the minimum thickness requirements for air drum brakes.

Because of the age of the bus and engine type, no recorded data were available. Although the battery box and electrical system were damaged during the collision and postcrash fire, investigators reviewed security video footage and determined that the headlamps were illuminated immediately prior to the crash. The fuel tank, located on the right side of the bus, was not compromised and was found to be 90 percent full of diesel fuel postcrash. An examination of the steering, suspension components, tires, and rims revealed no preexisting issues or deficiencies.

1.4.1.3 Inspection, Maintenance, and Safety Recalls. The *Federal Motor Carrier Safety Regulations* (*FMCSRs*), at 49 *CFR* 396.17, require that every commercial motor vehicle (CMV) be inspected periodically, at least once every 12 months. The motor carrier, Billy R. Evans, could not produce any maintenance records or evidence documenting that the bus had ever had an annual inspection. In addition, the company had no documented preventive maintenance program for any vehicles in the fleet. Billy R. Evans produced only a single work order for the accident bus.[24]

On June 29, 2016, the bus driver informed his supervisor that the brakes on the bus were not working properly.[25] According to the supervisor, the owner of the company had the brakes

[23] NTSB investigators were unable to measure the brake chamber push rod stroke because of fire damage to the internal components of the left steer axle brake.

[24] This work order—dated April 14, 2016—included replacing two sets of brake shoe springs, adjusting the fuel pump and brakes, and replenishing transmission oil.

[25] The bus driver provided this information during his interview with NTSB investigators.

fixed; and on July 1, both he and the driver tested the brakes to ensure that they were operating properly. Also, on July 1, the left rear tire was replaced at a tire shop in Bainbridge, Georgia. An FHP postcrash inspection of the bus identified no out-of-service (OOS) deficiencies. According to the manufacturer, Blue Bird Corporation, the bus had no open recalls or warranty claims.

1.4.2 Truck-Tractor

1.4.2.1 Damage. The truck-tractor was a 2005 Freightliner Columbia CL120 with a 2016 Kentucky enclosed moving semitrailer.[26] The full extent of collision damage to the front of the vehicle could not be determined because of the postcrash fire, which consumed all of the cab body panels—leaving only the frame rails, engine, and driveline components. The frame rails, near the front of the vehicle, were displaced to the left. The fire damaged the semitrailer box down to the floor bed. Figure 6 shows the remains of the truck-tractor and semitrailer.

Figure 6. Damage to truck-tractor (left) and semitrailer (right).

1.4.2.2 Fuel Tank Damage and Specifications. The truck-tractor was equipped with dual side-mounted fuel tanks, one on each side. The collision and postcrash fire damaged both tanks. The left-side tank was deformed, with melted and solidified remnants of material present in the inner shell. The right-side tank was compromised; the security video footage showed a fire explosion at the right side of the truck-tractor when it first engaged with the bus. There were also signs of ignited fuel pooling in the tanks. Postcrash, the right-side fuel tank was located underneath the bus.[27] Figure 7 shows the remains of this tank.

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[26] Based on truck scale weight ticket information provided by Verity Van Lines, the total weight of the truck-tractor semitrailer (including cargo and occupants) was 54,820 pounds at the time of the crash.

[27] A WCFD volunteer witnessed the crash and arrived at the scene shortly after the vehicles came to final rest. He reported seeing the fire spread "relatively fast," and observed that one of the fuel tanks was ruptured and had rolled under the bus.

Figure 7. Remains of right-side fuel tank at impound facility, showing both exterior and interior views.

On this truck-tractor model, the fuel tanks are mounted behind the front axle and beneath the cab. They are held in place by three steel straps attached to the frame. Each cylindrical fuel tank is constructed of 1/8-inch-thick aluminum, is 86.75 inches long, and has a diameter of 23 inches. Outboard of the fuel tanks, two aluminum steps are attached to the two mounting straps closest to the front of the cab. Figure 8 shows an exemplar Verity Van Lines truck-tractor and the mounting location of the fuel tank.

Figure 8. Exemplar Verity Van Lines truck-tractor showing location of right-side-mounted fuel tank and two aluminum steps.

1.4.2.3 Mechanical Systems. The collision and postcrash fire damage precluded a direct functional inspection of the air and braking systems; examination of driver controls, steering system, and electrical system; or documentation of tires. An examination of the visible brake and suspension components revealed no preexisting issues or deficiencies. The truck-tractor was powered by a Cummins ISX diesel engine, which was equipped with a Cummins electronic control module (ECM). The fire damaged the ECM, and no data were recovered. The truck-tractor was also equipped with a Meritor WABCO antilock brake system (ABS) module, which monitors brake applications and improves vehicle braking performance. The electronic ABS module contained no relevant crash data.

1.4.2.4 Inspection, Maintenance, and Safety Recalls. The most recent inspections of the truck-tractor were completed in January and June 2016. The semitrailer was last inspected in November 2015. No deficiencies were noted in any of these inspections. Verity Van Lines maintains an ongoing preventive maintenance program, including records of all maintenance performed and copies of daily vehicle inspection reports. According to Freightliner, the manufacturer of the truck-tractor, the vehicle did not have any open recalls or warranty claims.

1.5 Driver Factors

1.5.1 Bus Driver

1.5.1.1 Licensing and Experience. The bus driver, a 56-year-old male, held a Florida class B commercial driver's license (CDL) with passenger and school bus endorsements.[28] The license was issued in April 2014 and expired in May 2022. The driver attended Metropolitan Trucking and Technical Institute in West Palm Beach, Florida, from 2013 to 2014, where he was trained to drive motorcoaches. Academy Bus hired him in July 2014 as a shuttle bus driver; however, that employment was terminated in April 2015 because of repeated traffic violations captured by an in-vehicle video monitoring system. These violations included three instances of running a stop sign/light, two rolling stops, and one violation for stopping substantially past the intersection limit line.[29] He then worked for Pero Family Farms Food Company from January to April 2016, during which time he was involved in a crash while driving a bus transporting migrant AG workers. The driver was issued a citation, but the charges were dismissed after he successfully argued that he had the right-of-way. In April 2016, Billy R. Evans hired the driver.

According to the commercial driver's license information system (CDLIS), the bus driver had one speeding violation and one property damage crash, but neither of these occurred while

[28] A class B license allows a CDL holder to operate straight trucks and buses with a gross vehicle weight rating (GVWR) of 26,001 pounds or more.

[29] The in-vehicle video monitoring system was triggered by either hard braking or hard cornering events. Each violation of traffic control devices occurred at a speed of 25 mph or less and was preceded by braking. There is no record that the driver received a traffic citation for these violations.

operating a CMV.[30] The bus driver's license had not been revoked, canceled, or denied, but it was suspended in 2013 for failure to maintain insurance on a private vehicle.

1.5.1.2 Medical Certification, Health, and Toxicology. At the time of the crash, the bus driver was medically certified to operate a CMV in accordance with the requirements of 49 *CFR* 391.41. Medical records indicated normal vision, with a peripheral vision of 100 degrees for each eye (minimum allowable is 70 degrees). Records showed that the driver had a history of hypertension. He received his most recent US Department of Transportation (DOT) medical examination on May 11, 2016, at which time elevated blood pressure was recorded. There were no other significant findings. Consistent with regulations found at 49 *CFR* 391.43, he was provided with a medical certificate valid for 3 months, expiring on August 10, 2016. A review of medical and pharmacy records indicated that the driver had been prescribed medication for hypertension. During his postcrash visit to the hospital, he reported taking lisinopril and hydrochlorothiazide.[31]

The FHP obtained blood from the bus driver postcrash and forwarded a portion of the blood specimen to the Federal Aviation Administration (FAA) Bioaeronautical Sciences Research Laboratory. The analysis detected no alcohol or other tested-for drugs in the driver's blood.[32]

1.5.1.3 Precrash Activities. NTSB investigators interviewed the bus driver, his supervisor, and bus passengers to establish his activities in the days prior to the crash. Investigators could not rely on time card or logbook entries, because the driver did not maintain either form of record—nor was he required to do so by his employer.[33] His cell phone records were reviewed, but there was no evidence that the driver had used his phone between June 27 and July 2. When interviewed by the FHP, the driver said that he was not feeling tired on his return trip to Belle Glade, because he was talking to people on the bus. When questioned further, he said that he was not talking with anyone immediately prior to the crash.[34] Table 2 presents a timeline of the driver's activities from June 29–July 2, 2016.

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[30] The Commercial Motor Vehicle Safety Act of 1986 established CDLIS based on the *FMCSRs* at 49 *CFR* Parts 383 and 384. The American Association of Motor Vehicle Administrators (AAMVA) administers CDLIS, which allows state driver licensing agencies to ensure that each commercial driver has only one driver's license and one complete driver record. State driver licensing agencies use CDLIS to transmit out-of-state convictions, to transfer driver records, and to respond to requests for driver status and history.

[31] (a) Lisinopril is a prescription medication for high blood pressure that works by inhibiting angiotensin-converting enzyme. (b) Hydrochlorothiazide is a diuretic prescription medication used to treat high blood pressure.

[32] The drugs tested for include licit and illicit substances, prescription and over-the-counter medications, and many of their metabolites. For a complete list, see the FAA drug database, accessed September 16, 2017.

[33] Although Billy R. Evans did not require that its drivers maintain logbooks, the FMCSR requirement for logbooks, at 49 *CFR* 395.8, applies to this motor carrier operation. See section 1.7.1.4 for additional information.

[34] Passengers interviewed stated that they were asleep immediately prior to the crash and could not provide any information regarding the driver's precrash activities.

Table 2. Precrash activities of bus driver, June 29–July 2, 2016.

Time	Description[a]
Wednesday, June 29, 2016	
4:00 a.m.	Awakes
6:00	Departs temporary housing in Bainbridge, Georgia, and begins drive to Camilla with farm workers
6:00 a.m.–5:00 p.m.	Works at corn field (makes boxes, assists with other duties as needed)
~ 5:00	Drives workers to Bainbridge
8:00 p.m.	Goes to bed
Thursday, June 30, 2016	
4:00 a.m.	Awakes
6:00	Departs Bainbridge and begins drive to Camilla with farm workers
6:00–11:00	Works at corn field (makes boxes, assists with other duties as needed)
11:00	Drives workers to Bainbridge
8:00 p.m.	Goes to bed
Friday, July 1, 2016	
Unknown	Awakes, no work scheduled
Unknown	Picks up paycheck
Unknown	Loads belongings into U-Haul truck
Unknown	Tests repaired brakes on bus[b]
Unknown	Drives bus to Delta Tires in Bainbridge to replace left rear tire[b]
9:00 p.m.	Goes to bed
Saturday, July 2, 2016	
1:30 a.m.	Awakes
Unknown	Inspects bus before trip
3:30	Departs Bainbridge for return trip to Belle Glade, Florida[c]
5:16 a.m.	**Crash occurs**

[a] All information was obtained from NTSB investigator interviews with the bus driver unless otherwise noted.

[b] The bus driver's supervisor provided this information to NTSB investigators.

[c] Prior to departing Bainbridge at 3:30 a.m., the bus driver drove to other farming locations in the area to pick up workers wanting to return to Belle Glade.

1.5.1.4 Work Environment. While in Bainbridge, the bus driver stayed in temporary housing provided by Billy R. Evans and shared a room with his sister. Daily farm work in the fields of Camilla included a variety of jobs, including picking corn, making boxes, and operating farm equipment.

Although the bus driver was hired to drive a bus for Billy R. Evans, he explained that he also worked making boxes and was paid based on the number of boxes of corn that were packed in a day. Payroll records show that he worked in the corn field for 22 of the 28 days from June 4 to July 1. Two other box builders, who worked alongside the driver, described the work as grueling because it required being in the hot sun. One of the boxers reported that he was concerned about the driver's health because he was older and taking medication.[35] The driver said that at the end of the day he was very tired, took a shower, and went to sleep.

1.5.2 Truck Driver

1.5.2.1 Licensing, Medical Certification, and Health. The truck driver, a 55-year-old male, had worked for Verity Van Lines since 1988. He held a New York class A CDL with double/triples and liquid bulk endorsements.[36] The license was issued in June 2009 and expired in June 2017. He was required to wear corrective lenses, and his passenger stated that the driver wore his glasses "all the time."

At the time of the crash, the truck driver was medically certified to operate a CMV. In his most recent CDL medical examination, conducted in November 2014, no medical issues were identified, and he received a 2-year DOT medical certification. No medications (prescribed or over-the-counter) were listed on his DOT medical forms. His autopsy identified severe coronary artery disease with no evidence of previous damage to the heart muscle.

1.5.2.2 Toxicology. The University of Florida pathology laboratories conducted toxicology testing of a blood sample, but no results could be determined because of the limited quantity of blood. A followup liver tissue sample was then used to test for the presence of alcohol and other drugs. This test did not identify the presence of commonly abused drugs, but ethanol was documented at 0.084 gram per deciliter (g/dL).[37] The University of Florida laboratories forwarded kidney and liver specimens to the FAA. Testing by its Bioaeronautical Sciences Research Laboratory found 0.092 g/dL of ethanol in the kidney sample and 0.088 g/dL of ethanol in the liver sample. Because microbial activity in the body tissue after death can produce ethanol, it is not possible to determine how much of the identified ethanol in the tissue specimens originated from ingestion or postmortem production.

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[35] This coworker reported that he could "see the salt coming out of his skin" and would see the bus driver "turn white." The worker added that the driver was afraid of his supervisor because he was very intimidating.

[36] A New York class A CDL permits the holder to operate a vehicle with a gross combination weight rating (GCWR) of more than 26,000 pounds, provided that the GVWR or GCWR of vehicle(s) being towed exceeds 10,000 pounds.

[37] Ethanol is commonly found in beer, wine, and liquor, and acts as a central nervous system depressant.

1.5.2.3 Precrash Activities. NTSB investigators interviewed both the passenger and the motor carrier to establish the truck driver's activities in the days prior to the crash. Although the Verity Van Lines truck-tractor was equipped with a sleeper berth, the driver elected to sleep at a hotel each night during his delivery trips. Review of the driver's cell phone records shows that he was not using his phone at the time of the crash. Table 3 presents a timeline of the truck driver's activities from June 29 to July 2, 2016.

Table 3. Precrash activities of truck driver, June 29–July 2, 2016.

Time	Description	Source
Wednesday, June 29, 2016		
3:30 a.m.	Awakes	Interview
5:15	Eats breakfast	Interview
6:50	Makes/takes first phone call of day[a]	Cell records
Unknown	Moves items for customer in Lakeworth, Florida	Interview
10:00	Delivers load to Boca Raton, Florida	Carrier records
2:00 p.m.	Completes delivery in Boca Raton	Carrier records
3:30	Arrives at hotel	Interview
Unknown	Goes to restaurant	Interview
6:51	Makes/takes last phone call of day	Cell records
7:30	Watches television	Interview
8:00 p.m.	Goes to bed	Interview
Thursday, June 30, 2016		
3:30 a.m.	Awakes	Interview
6:00	Makes/takes first phone call of day	Cell records
Unknown	Delivers load to Palm Harbor, Florida	Carrier records
Unknown	Moves items from straight truck to his truck	Carrier records
7:33 p.m.	Makes/takes last phone call of day	Cell records
8:00 p.m.	Goes to bed	Interview
Friday, July 1, 2016		
Unknown	Awakes	Interview
6:48 a.m.	Makes/takes first phone call of day	Cell records
Unknown	Drives to Madison, Florida (4.5 hours away)	Interview
12:00 p.m.	Arrives at hotel	Interview
5:00	Goes to restaurant in Madison	Interview
6:00	Returns to hotel	Interview
6:15	Makes/takes last phone call of day	Cell records

Time	Description	Source
8:00 p.m.	Goes to bed	Interview
Saturday, July 2, 2016		
~ 3:00 a.m.	Awakes	Interview
4:10	Departs Madison en route to St. James Island, Florida	Interview
5:16 a.m.	**Crash occurs**	

[a] Not all cell phone calls and text messages are listed. For additional details, see the NTSB public docket and search for accident ID HWY16MH019.

1.6 Highway Factors

1.6.1 Design and Traffic Control

The crash occurred at the US-98–SR-363 intersection in Wakulla County, near St. Marks. It is a four-leg intersection with an angular approach of about 90 degrees. At this location, US-98 is an east–west, major rural arterial with one 12-foot-wide lane for each direction of travel. Overhead flashing yellow traffic control beacons control traffic.[38] The average daily traffic (ADT) measured east of the intersection is 1,100 vehicles per day, with 18 percent heavy vehicle traffic. The posted speed limit is 45 mph.

At this location, SR-363 is a minor rural arterial. The ADT is 3,100 vehicles per day, with 6.2 percent heavy vehicle traffic. The posted speed limit is 45 mph. The intersection approach for SR-363 south consists of a 12-foot-wide through lane, a bike lane, and a dedicated right-turn lane that begins about 425 feet from the intersection. A 36- by 36-inch stop sign and overhead flashing red traffic control beacons control traffic. The stop sign is augmented by a 24-inch-wide stop line with “STOP” painted on the roadway.[39] The stop sign has a plaque beneath it warning motorists that cross traffic does not stop. A “STOP AHEAD” warning sign is posted about 450 feet from the intersection. Figure 9 shows the SR-363 south approach to the intersection with US-98.

[38] The Florida Department of Transportation (FDOT) installed these intersection control beacons in 1958. They consist of two horizontally aligned circular beacons centered over US-98 and two over SR-363. The beacon array is located about 17.5 feet above ground level and flashes at a rate of once per second.

[39] The stop sign is mounted 9 feet above the ground and positioned laterally 17 feet from the white shoulder line. This sign is offset about 40 feet from the centerline of the SR-363 through lane on which the bus was traveling.

Figure 9. SR-363 south approach to intersection with US-98, with yellow circle denoting vacant building.

A vacant building at the northeast corner of the intersection partially obscures the views on southbound and westbound approaches (see also figure 2). Until the line of sight for each driver extended beyond the corner of this building, neither driver would see approaching traffic on the cross highway.

In 2006 and 2011, the Florida Department of Transportation (FDOT) conducted traffic engineering studies to determine if additional safety improvements were needed at this location.[40] Neither study showed that the intersection met the threshold limits for vehicle volume and crash experience found in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) for warranting the installation of a traffic signal or artificial lighting (Federal Highway Administration [FHWA] 2009b).[41]

[40] The 2006 study was initiated by a citizen request to determine if a traffic signal was warranted. The 2011 study was initiated by the FDOT operations center to examine the need for a dedicated right-turn lane to minimize traffic congestion at the intersection.

[41] A jurisdiction has authority to install a traffic control signal at any location based on engineering judgment, supported by warrants described in the MUTCD, which provide minimum thresholds based on average or normal conditions. Because the crash location did not meet the minimum thresholds for traffic volume and crash history, the jurisdiction determined that a traffic control device was not justified.

1.6.2 Pavement Improvement Project

SR-363 had recently been repaved as part of a 5.9-mile-long pavement improvement project. On March 23, 2016, the permanent transverse rumble strips were removed from the roadway surface during milling operations.[42] On June 3—a month before the crash—SR-363 was repaved, the edge lines and centerline were painted, and rumble strips were installed on the shoulder and centerline. The transverse rumble strips were not reinstalled until 6 days after the crash, on July 8. The construction contract did not include any special provisions or requirements that the rumble strips be reinstalled within a certain number of days.[43] In addition, there were no contract requirements or guidance for the installation of temporary transverse rumble strips as an interim safety countermeasure.

The new rumble strips consist of four arrays that begin about 925 feet north of the intersection. Each array includes four 9-foot-long, 40-inch-wide strips spaced at 5-foot intervals. The thermoplastic strips are white and retroreflective to improve nighttime visibility. Each strip is raised about 0.5 inch above the surface. The other arrays of transverse rumble strips are located about 725 feet, 595 feet, and 517 feet from the intersection. Figure 10 highlights the first array of rumble strips, located 925 feet north of the intersection.

Figure 10. Postcrash view of one array of reinstalled transverse rumble strips on SR-363 south, 925 feet in advance of intersection.

[42] Transverse rumble strips are "intermittent narrow, transverse areas of slightly raised or depressed road surface that extend across the travel lanes to alert drivers to unusual vehicular traffic conditions. Through noise and vibration, they attract the attention of road users to features such as unexpected changes in alignment and conditions requiring a reduction in speed or a stop" (FHWA 2009a).

[43] The contractor schedule showed that the roadway striping and reinstallation of rumble strips was planned for the final phase of the project, in mid-July. No legal requirement imposed a deadline for the reinstallation of rumble strips following the repaving phase of the project.

1.6.3 Transverse Rumble Strip Testing and Research

On July 11, 2016, NTSB investigators rode in a test vehicle that traveled over the transverse rumble strips on the SR-363 north and south approaches to the intersection at the posted 45-mph speed limit.[44] The testing revealed an increase in haptic vibrations but no noticeable increase in sound level. Additionally, nighttime drive-through testing demonstrated that the white retroreflective thermoplastic rumble strips were clearly visible when illuminated by vehicle headlamps.

Transverse rumble strips are used by transportation agencies across the United States as a speed reduction countermeasure and as a safety treatment to warn drivers of an approaching stop sign. A study of 154 stop-controlled rural intersections in Minnesota and Iowa showed a 39 percent reduction in fatal and incapacitating injury crashes at intersections with transverse rumble strips (Srinivasan, Baek, and Council 2010).[45]

1.6.4 Crash History

According to FDOT, 29 crashes were reported at this intersection between 2003 and 2016—15 of which were right angle crashes resulting from running the stop sign or failing to yield the right-of-way. In reviewing 2 years of FHP crash reports, NTSB investigators identified three crashes between June 2014 and June 2016 in which the cause was determined to be drivers on SR-363 running the stop sign and moving into the path of vehicles on US-98.[46] The July 2, 2016, crash is the only fatal crash reported at this intersection in the last 13.5 years. Twelve other crashes in this same period resulted in injuries.

1.6.5 Weather, Visibility, and Lighting

Data from the weather station at the Tallahassee International Airport, 16 miles northeast of the crash site, indicated that—on July 2, 2016, at 4:53 a.m.—the temperature was 75.9°F, with calm winds and clear weather conditions. According to the US Naval Observatory, on the day of the crash, morning civil twilight occurred at 6:12 a.m. and sunrise at 6:39 a.m. The crash occurred in darkness, about 5:16 a.m.

The SR-363 south approach to the crash scene has no artificial lighting. The parking lots of the two buildings on the north side of the intersection had no lighting because the buildings were vacant. US-98 has no dedicated intersection street lighting, but the parking lot of a gasoline station in the southeast corner provides ambient lighting. During drive-through testing at the crash

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[44] A Wakulla County 2001 Blue Bird 89-passenger school bus—with a front engine configuration similar to the accident bus—was used for the testing because no 1979 Blue Bird bus was available. An Extech Instruments model SDL 600 sound level meter was used for sound pressure readings. Testing was also conducted using a passenger vehicle, and observers could easily hear and feel the haptic vibrations when traveling over the rumble strips.

[45] Although the study revealed a significant reduction in serious injury crashes, it also showed an increase in property damage only (PDO) crashes. Researchers suggested that the increase in PDO crashes was likely due to a shift from more severe to less severe crash types (for example, right-angle crashes decrease while rear-end crashes increase).

[46] Two of the crashes involved injuries, and one was property damage only. One of the three crashes occurred in darkness.

location, it was determined that—because of the darkness and the straight highway configuration—the flashing red traffic control beacons were visible on SR-363 from 2.8 miles north of the intersection.

1.7 Motor Carrier Operations

1.7.1 Billy R. Evans Harvesting, Inc.

1.7.1.1 General Information. Billy R. Evans Harvesting, Inc., was registered with the Federal Motor Carrier Safety Administration (FMCSA) as a private passenger motor carrier. At the time of the crash, the company's principal place of business was in Belle Glade, Florida. According to the carrier's insurance policy, it owned and operated 11 commercial vehicles, including four repurposed school buses, six straight trucks, and one pickup truck.[47] Billy R. Evans employed 50–125 people who worked at several farms throughout the year, primarily in Florida and Georgia.

1.7.1.2 Company History. In December 2004, the carrier applied for interstate operating authority. The FMCSA issued US Department of Transportation (USDOT) number 1310998 and entered Billy R. Evans into the new entrant safety assurance program.[48] All new entrant carriers are subject to an 18-month safety-monitoring period, during which the FMCSA conducts a safety audit and evaluates the company's safety management practices and on-road performance data.

On April 28, 2005, the FMCSA conducted a new entrant safety audit of Billy R. Evans. The company passed the audit, though the FMCSA noted numerous deficiencies.[49] In a letter dated May 5, 2005, the FMCSA encouraged Billy R. Evans to take appropriate actions to promptly comply with the following regulations:

- Driving/employment history: 49 *CFR* 391.51(b)(2)
- Driver medical certificates: 49 *CFR* 391.45(a)
- Driver qualification files: 49 *CFR* 391.51(a)
- Drug/alcohol testing program: 49 *CFR* 382.115(a)
- Making and submitting a record-of-duty status: 49 *CFR* 395.8(a) and 49 *CFR* 395.8(i)

[47] Straight trucks are large trucks (GVWR exceeding 10,000 pounds) with typically nondetachable cargo units, which have all axles attached to a single frame.

[48] All motor carrier new entrants must obtain a USDOT number. This number serves as the unique identifier for the carrier when collecting and monitoring its safety information acquired during audits, compliance reviews (CR), accident investigations, and inspections.

[49] Failure of a new entrant safety assurance audit was rare during the first several years of the program. In February 2009, the safety audit software was updated to include specific violations that would result in automatic failure. A carrier automatically fails a safety audit for significant violations related to alcohol and drugs, the driver, operations, or repairs and inspections.

- 100 air-mile radius driver policy: 49 *CFR* 395.1(e)
- Maintenance files: 49 *CFR* 396.3(b)
- Periodic inspection: 49 *CFR* 396.17(a).

Following the new entrant safety audit, there were no FMCSA compliance reviews (CR) of Billy R. Evans safety management practices until after the crash.

1.7.1.3 Carrier Registration. The motor carrier identification report (form MCS-150) contains details such as the type of operation (interstate, intrastate), classification (authorized for-hire, private passenger, or migrant), cargo classification, carrier mileage, and company equipment. The FMCSA requires that the MCS-150 be updated every 2 years. Billy R. Evans was not in compliance with the biennial update requirement and had submitted the MCS-150 only in 2004 and 2008. The carrier also described its operations as being "intrastate" on the 2008 MCS-150 filing, though it engaged in interstate operations from 2008 to 2016.[50]

1.7.1.4 Operating Practices. Billy R. Evans had no driver handbook and no written safety policies, including drug and alcohol, seat belt, fatigue management, cell phone, or discipline policies. The carrier conducted no in-service training and had no program for monitoring driver hours of service.[51] It also had no formal method of hiring drivers and did not conduct background checks or validate CDLs through the Florida Department of Highway Safety and Motor Vehicles. The carrier's only hiring practice was to request a copy of the CDL and check to see if it had a "P" endorsement allowing for the transportation of passengers.

During an NTSB postcrash review of Billy R. Evans, the carrier failed to produce a driver qualification file for any of its drivers.[52] Likewise, the carrier could not produce any DOT pre-employment drug or alcohol tests.[53] Billy R. Evans management informed investigators that its payroll vendor, On-Site AG Services, Inc., was responsible for driver qualification and drug testing. NTSB investigators contacted that company, and it denied having any responsibility for qualifying drivers or performing DOT drug testing services.[54]

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[50] Intrastate operations receive less scrutiny by federal regulators than interstate operations.

[51] Title 49 *CFR* 395.8 requires motor carriers to ensure that each driver maintain a daily record-of-duty status detailing the hours driven and the hours spent off duty. Billy R. Evans failed to produce any logbooks or time sheets for the accident driver. Carrier management stated that it did not require or maintain logbooks or time records for any drivers and stated that it "thought logs were only required if trips were over 8 hours."

[52] Title 49 *CFR* 391.51 requires that the driver qualification file include the application for employment, a copy of the motor vehicle record from the state driver licensing agency, information about violations of motor vehicle laws, road test results, an annual review of violations, and a medical examiner's certificate.

[53] Title 49 *CFR* Part 382 requires that carriers have a drug and alcohol testing program. Part 382 includes four categories of drug/alcohol testing: pre-employment, random, postaccident, and reasonable suspicion.

[54] On-Site AG Services, of Sebring, Florida, is a payroll and tax services company and does not perform DOT drug testing.

1.7.2 FMCSA Oversight

1.7.2.1 Carrier Performance Monitoring and Intervention. The FMCSA uses roadside inspection, crash report, and investigation data to identify and intervene with motor carriers that pose the greatest risk to safety. The carrier safety measurement system (CSMS) is the FMCSA workload prioritization tool to assess motor carrier on-road performance and compliance.[55] It organizes carrier data into seven behavior analysis and safety improvement categories (BASIC): unsafe driving, crash indicator, hours-of-service (HOS) compliance, vehicle maintenance, controlled substances/alcohol, hazardous materials compliance, and driver fitness.

For each BASIC, the CSMS calculates a quantifiable measure of the carrier's performance and then groups carriers by size and number of safety events (that is, crashes, inspections, or violations). The CSMS ranks the carriers based on their BASIC scores and assigns a percentile from 0–100 (the higher the percentile, the worse the safety performance). The FMCSA has established threshold levels that require agency action. No score is assigned if a carrier does not have enough roadside inspections or violations.

A review of Billy R. Evans CSMS data for the 2 years preceding the crash showed that the carrier did not have enough roadside interventions to receive a score. The carrier profile reflected only one roadside inspection, which occurred on April 25, 2015, in South Bay, Florida. It resulted in four OOS violations; however, the inspection did not involve the accident bus or the accident driver.

1.7.2.2 Postcrash Compliance Review and Enforcement Action. The FMCSA conducted a postcrash CR of Billy R. Evans and found noncompliance with the *FMCSRs*. As a result of the 21 federal and state violations identified, the carrier received an unsatisfactory safety rating; was issued an imminent hazard order on July 29, 2016; and was placed out of service. The basis for the imminent hazard order included the following violations:

- Failure to comply with any driver qualification requirements: 49 *CFR* Part 391.
- Failure to implement an alcohol or controlled substances testing program: 49 *CFR* Part 382.
- Failure to comply with vehicle maintenance or inspection requirements: 49 *CFR* Part 396.
- Failure to comply with HOS regulations: 49 *CFR* Part 395.
- Failure to maintain the most basic safety and business records: 49 *CFR* Part 379.
- Failure to register and submit an MCS-150 form: 49 *CFR* Part 390.

[55] See the FMCSA Compliance, Safety, Accountability (CSA) website, accessed September 18, 2017.

1.7.3 US Department of Labor Oversight

1.7.3.1 Regulatory Authority and Responsibilities. The Migrant and Seasonal Agricultural Worker Protection Act (MSPA), incorporated into 29 *CFR* Part 500, outlines the federal regulatory oversight of farming operations that employ migrant or seasonal AG workers.[56] The US Department of Labor (DOL)–Wage and Hour Division (WHD) establishes standards for wages, housing, transportation, and recordkeeping for farm workers. In addition to enforcing the MSPA, the WHD is responsible for enforcing the federal minimum wage, overtime pay, recordkeeping, the Family and Medical Leave Act, wage garnishment provisions of the Consumer Credit Protection Act, the Employee Polygraph Protection Act, and child labor requirements of the Fair Labor Standards Act.

1.7.3.2 Farm Labor Contractor Requirements. An FLC is any person or business that participates in farm labor contracting activities, such as recruiting, soliciting, hiring, employing, furnishing, or transporting migrant or seasonal AG workers. Before performing any farm labor activities, FLCs are required to obtain a DOL certificate of registration, which authorizes the applicant to engage in "farm labor contracting activities."[57] Additionally, every FLC must comply with the provisions of the MSPA, including the motor vehicle safety and insurance standards given in subpart D of 29 *CFR* Part 500.[58] Furthermore, the certificate of registration must include the identity of each vehicle intended to be used in the transportation of workers.

The DOL FLC website lists 9,800 authorized contractors nationwide, which includes 2,475 in the state of Florida.[59] At the time of the crash, Billy R. Evans was a registered and authorized FLC. The carrier's certificate of registration, however, authorized only two 1995 Blue Bird buses to be used in the transportation of workers—which excludes the crash-involved 1979 Blue Bird bus. For the accident bus to have been certified, a vehicle mechanical inspection report would have had to be completed and an inspection performed by an independent company not affiliated with the FLC.[60] NTSB investigators found no such records.

1.7.3.3 DOL–WHD Oversight. Prior to the crash, the DOL–WHD had very little contact with Billy R. Evans and had no record of ever visiting the company's principal place of business in Belle Glade, Florida. On June 22, 2016, however—less than 2 weeks before the crash—a WHD investigator completed a spot check of the carrier's operations in Bainbridge, Georgia. The

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[56] A migrant AG worker is an individual employed in seasonal or other temporary agricultural work who is required to be absent overnight from his or her permanent place of residence. In contrast, a seasonal AG worker is an individual who is employed in agriculture but is not required to be absent overnight from his or her permanent place of residence (29 *CFR* 500.20(r)).

[57] Title 29 *CFR* 500.1(c) authorizes state agencies to issue such certificates on behalf of the DOL. Billy R. Evans was issued a certificate of registration by the Florida Department of Business and Professional Regulation (DBPR).

[58] Title 29 *CFR* 500.70(c) provides transportation-related protections to the AG employer (farmer) who uses an FLC for the transportation of AG workers and states specifically that "these regulations do not impose responsibility on an agricultural employer or agricultural association for a farm labor contractor's failure to adhere to the safety provisions provided in these regulations when the farm labor contractor is providing the vehicles and directing their use."

[59] See the current DOL list of registered FLCs, accessed September 19, 2017.

[60] Title 29 *CFR* 500.100(b) states that the presence of a current state vehicle inspection sticker provides prima facie evidence that safety standards have been met.

investigator completed a walk-around of the 1979 Blue Bird bus but did not conduct a database check to see if it was appropriately inspected and authorized for the transportation of workers. Figure 11 shows the right side of the bus in a precrash photograph taken by the WHD investigator.

Figure 11. Precrash photograph of accident bus taken during DOL–WHD spot check of Billy R. Evans on June 22, 2016. (Source: DOL)

Following the crash, the DOL–WHD initiated an investigation of Billy R. Evans, which resulted in the following violations of the MSPA:

- Failure to provide safe transportation vehicles
- Failure to obtain prescribed insurance coverage
- Transportation of workers without certificate authorization.

1.7.4 State of Florida Oversight

The farm labor program of the Florida Department of Business and Professional Regulation (DBPR) promotes and ensures compliance with farm labor laws, rules, and standards. The program is staffed by 16 investigators assigned to agriculturally significant areas of the state.

Billy R. Evans was appropriately authorized as an FLC in the state of Florida, but the accident bus was not approved because it was not inspected and issued an inspection sticker.

The DBPR had no record of any enforcement or inspection contact with Billy R. Evans other than the registration process. Following the crash, the agency investigated the carrier and cited it with the following violations:

- Transportation vehicle did not have proper worker’s compensation insurance.
- Transportation vehicle did not have proper liability insurance.

- Contractor was operating transportation vehicle without agency authorization.
- Transportation vehicle did not have a current safety inspection.
- Contractor was using a vehicle to transport farm workers that did not display the required DBPR inspection sticker.

1.7.5 Verity Van Lines, Inc.

1.7.5.1 General Information. Verity Van Lines, Inc., of Seaford, New York, is registered as a household goods carrier and has current operating authority. The carrier maintains a client base in the New York City metropolitan area and operates on the eastern seaboard as a moving company. Verity Van Lines employs eight CDL drivers and operates seven truck-tractors, 10 straight trucks, and 10 semitrailers.

1.7.5.2 Operating Practices. Verity Van Lines has limited turnover of drivers and uses a referral process for new hires. A graduated step training program monitors the progress of drivers as they advance from employment as a loader, to a small van driver, to a midsize truck driver, to a CDL driver authorized to operate company truck-tractors. The carrier conducts monthly safety meetings and incentivizes drivers through a safety bonus program. Drivers are also rewarded through monetary programs for zero violations of roadside inspections and for customer service reviews. Verity Van Lines maintains a zero-tolerance drug program and cell phone use policy, and requires that its drivers wear seat belts. The carrier maintains a random drug and alcohol testing program and had three negative tests on file for the truck driver.[61] According to the CSMS, its OOS rate for driver and vehicle violations is lower than the national average.[62]

1.8 Other NTSB Investigations

The NTSB has conducted two other recent investigations involving the transportation of migrant AG workers—in Little Rock, Arkansas, and in Ruther Glen, Virginia.

1.8.1 Little Rock, Arkansas

1.8.1.1 Crash Overview. On Friday, November 6, 2015, at 12:55 a.m., a 1997 Van Hool motorcoach, operated by Vasquez Citrus and Hauling—and occupied by a 28-year-old driver, a codriver, and 20 AG workers—was traveling west on Interstate 40 (I-40) in the right lane near Little Rock.[63] The crash sequence began when the motorcoach departed the roadway at a shallow angle and crossed rumble strips, traveled about 640 feet along the paved shoulder, and collided

[61] DOT drug tests, with negative results, were conducted on February 9, 2009, and September 29, 2011. A random DOT alcohol test, with a negative result, was administered on July 14, 2015.

[62] The national average OOS rates during roadside inspections are 5.5 percent for driver violations and 20.7 percent for vehicle violations.

[63] Vasquez Citrus and Hauling recruits workers from Mexico and sponsors them in the H-2A visa process. The visa is issued for a specific, limited time. The company transports the workers to Michigan and provides housing during the harvesting season in Monroe, Michigan. At the end of the season, Vasquez transports the workers back to Laredo, Texas, where they turn in their visas and leave the United States.

with a concrete barrier. Subsequently, the right front and rear portion of the vehicle roof struck a bridge column and the North Hills Boulevard overpass. Figure 12 shows the motorcoach postcrash. Six of the motorcoach occupants were fatally injured, and three of them had been ejected. The driver, codriver, and remaining passengers received injuries of varying degrees. Immediately following the crash, the driver submitted to a blood test performed by the Arkansas State Police. The test results for alcohol and other drugs were negative.

Figure 12. View of Little Rock, Arkansas, motorcoach, postcrash.

A postcrash inspection of the motorcoach and driver by Arkansas State Police commercial vehicle inspectors identified numerous violations, including:

- No driver record-of-duty status (logbook).
- Driver operating a CMV while impaired by fatigue.
- Inadequate floor condition: hole in floor near driver's seat covered by carpet.
- Inspection, repair, and maintenance of parts: broken right rear motor mount.
- Inspection, repair, and maintenance of parts: broken radiator hose near axle 3 under bus.

1.8.1.2 Precrash Events. The motorcoach had departed Monroe, Michigan, at 9:00 a.m. on November 5, 2015. The driver alternated shifts every 3–4 hours with a codriver. The crash occurred during the bus driver's second shift, after the vehicle had been on the road for more than 13 hours and 837 miles. At the time of the crash, the driver had been on duty for about 14 hours. During the postcrash interview, he said that he had rested in the first row of seats on the left side of the motorcoach while his codriver was operating the vehicle. A check of his cell phone records indicated that he made an outgoing call during one of the periods when he was reportedly resting.

While working in Michigan, the driver was paid based on a time card. From October 1 through November 4, 2015, he worked an average of 11.5 hours every day in the month of October and 9.5 hours on November 2 and 3. There were no time records for November 1 or 4.

1.8.1.3 Motor Carrier Information. Vasquez Citrus and Hauling was registered as a private passenger carrier. The carrier had two separate operations. In Florida, it hauled citrus fruit from the orchard to processing plants. In Michigan, it had a contract with Ruhlig Farms LLC, located in Carleton County. While in Michigan, the carrier's operations were exempt from many of the *FMCSRs*.[64] During daily operations, the motorcoach driver was not required to keep a record-of-duty status (logbook). On the return trip from Michigan to Texas, however, he was required to maintain a logbook, because he was engaged in the interstate transportation of passengers. The driver stated in an interview with NTSB investigators that he had not filled out a logbook. Investigators interviewed carrier management and were told that nobody at the company monitored driver hours of service because its operations were exempt.

A review of records at Vasquez Citrus and Hauling revealed that the carrier did not have any written policies, procedures, or company handbook and that the driver qualification file did not comply with regulations. The carrier advised NTSB investigators that because its operations were agricultural and mostly exempt, the file contained only those documents needed to meet state requirements; management stated that it considered agricultural operations to be exempt from federal regulations. The carrier did not provide driver training, nor did it have any training material or recurring training to ensure safe operations—or any drug or alcohol testing program.

A review of roadside inspection data for Vasquez Citrus and Hauling operations showed that the carrier had six vehicle roadside inspections from April 15, 2014, to November 7, 2015. The driver OOS rate was 33 percent, and the vehicle OOS rate was 37.5 percent, both of which are higher than the national averages of 5.5 percent and 20.7 percent, respectively. Additionally, at the time of the crash, the carrier was in an alert status for being over the CSMS threshold in the vehicle maintenance BASIC and had a history of problems in other safety categories. During the 2 years leading up to the crash, the carrier was in an alert status in the vehicle maintenance BASIC for 19 months, in the crash indicator BASIC for 12 months, and in the unsafe driving BASIC for 5 months.[65]

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[64] Section 32101 of the Moving Ahead for Progress in the 21st Century Act provides a statutory exemption from the HOS regulations. Section 32934 provides certain "covered farm vehicles" statutory exemption from most of the FMCSRs, including CDL standards (49 *CFR* Part 383); controlled substances and alcohol use and testing (49 *CFR* Part 382); physical qualifications and examinations (49 *CFR* Part 391); hours of service (49 *CFR* Part 395); and inspection, repair, and maintenance (49 *CFR* Part 396).

[65] (a) The vehicle maintenance BASIC involves a failure to properly maintain a CMV or to properly prevent shifting loads. Example violations include brakes, lights, and other mechanical defects; failure to make required repairs; and improper load securement. (b) The crash indicator BASIC involves a history or pattern of high crash involvement, including frequency and severity based on information from state-reported crashes. (c) The unsafe

Vasquez Citrus and Hauling had two recordable accidents in the year before the crash, both of which occurred in Florida while transporting agricultural products.

1.8.1.4 Federal and State Oversight. Vasquez Citrus and Hauling began operations in 1979 and was issued operating authority in 2005. From 2005 to 2015, it was registered as an intrastate carrier and was not entered into the new entrant safety program.[66] From the date the company received operating authority, the FMCSA had conducted no interventions. Additionally, the carrier had never been subject to a new entrant safety audit to ensure that it was safe to engage in interstate operations. Following the crash, the FMCSA conducted a CR and identified 10 violations of the FMCSRs, including one acute violation for failing to implement an alcohol or controlled substance testing program and two critical violations for failing to require the driver to make a record-of-duty status. The carrier was also found in violation for failing to inspect, repair, and maintain company vehicles. Vasquez received an unsatisfactory rating in the HOS category and was issued an overall conditional safety rating on January 22, 2016.[67]

The DOL–WHD had limited contact with Vasquez Citrus and Hauling prior to the crash. Likewise, the Florida DBPR advised that it had not completed any investigations of the carrier's operations, but it had issued farm labor licenses to the motorcoach driver and the codriver.[68] The FHP commercial vehicle section had completed CRs of the carrier on May 31, 2007, and on June 23, 2008. The 2007 review cited the carrier for failing to implement a controlled substance testing program and for failing to maintain required intrastate time records. The 2008 review was a result of a complaint that the carrier did not have insurance; the FHP found similar violations as in the 2007 inspection.

1.8.2 Ruther Glen, Virginia

1.8.2.1 Crash Overview. On Saturday, June 18, 2016, at 12:35 a.m., a 1998 Dodge Ram 15-passenger van was traveling north on Interstate 95 (I-95), in Ruther Glen, Virginia, en route to Hamilton, New Jersey. The van was occupied by a 50-year-old driver and 15 passengers, most of whom were migrant AG workers. As the van was traveling in the far left of the three northbound lanes of I-95, it departed the roadway onto the left shoulder and then swerved right across all three lanes of travel, striking a passenger car. The van then continued onto the right shoulder, with the rear of the vehicle swinging out of the roadway onto the grass. It overturned at least two times before coming to rest upright on the right shoulder.

Six of the van passengers (including a 4-year-old boy) were ejected and died, while the driver and the remaining passengers sustained injuries of varying degrees. Only the driver and the front passenger were wearing seat belts. NTSB investigators examined the seat belts in the four

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driving BASIC involves the operation of a CMV by drivers in a dangerous or careless manner. Example violations include speeding, reckless driving, improper lane change, and inattention.

[66] Despite being registered as an intrastate carrier, Vasquez Citrus and Hauling was engaged in interstate operations.

[67] A conditional safety rating means that a motor carrier does not have adequate safety management controls in place to ensure compliance with the safety fitness standards.

[68] The license must be renewed every year and include a background check and a written test to ensure knowledge of farm labor regulations.

passenger rows of seats; nine seat belts had been cut out (precrash), and four were found to be tied and twisted in knots. A postcrash vehicle inspection found no mechanical deficiencies. Additionally, a postcrash toxicology test of the van driver was negative for the presence of alcohol or other drugs. Figure 13 shows two postcrash views of the 15-passenger van.

Figure 13. Damage to Ruther Glen, Virginia, 15-passenger van.

1.8.2.2 Precrash Events. Payroll records showed that the van driver and other AG workers picked blueberries at a farm in Atkinson, North Carolina, during the week preceding the crash. At night, the driver and 13 other workers shared a rental house in Rocky Point.[69] The rental property did not have any furniture, and the driver said that he and the other workers slept on the floor. He said that he had not slept "very well" on the night before the crash because of having to think about all the activities planned for the following day. On June 17, he awoke about 7:00 a.m., worked all day preparing vehicles for the trip to New Jersey, and cleaned the rental property.

On the evening of June 17, the accident van and two other vehicles transporting AG workers all departed about 7:00 p.m. en route to the New Jersey farm, a distance of 533 miles. At the time of the crash, the driver had been on duty for 17.5 hours and had traveled 272 miles. During a postcrash interview, he told NTSB investigators that he "felt sleepy and fell asleep just before the accident."

1.8.2.3 For-Hire Van Operation. NTSB investigators interviewed the van driver (and owner of the vehicle), his son, and van passengers. The driver told investigators that he was a citizen of Mexico and had been working in the United States as a farm laborer for the past 8–9 years. The 15-passenger van was the only vehicle registered in his name; however, his wife owned an eight-passenger Pontiac Montana van, and his son owned a three-passenger Nissan Frontier pickup truck. The family operation consisted of the transportation and housing of migrant farm workers.

The driver said that he would often seek work at a local store in North Carolina that posted advertisements for pickers for the next harvest season. Interviews with the passengers indicated

[69] Rocky Point is about 22 miles from the farm location in Atkinson.

that they paid fees to the driver for both transportation and housing. Because the driver was engaged in the transportation of passengers for compensation, the driver and vehicles met the FMCSA definition of a “motor carrier.” At the time of the crash, the van operation did not have operating authority from the FMCSA or the DOL, the van did not have liability insurance, and the driver did not hold any type of driver’s license or DOT medical certificate.

1.8.2.4 Federal and State Oversight. Prior to the crash, there was no evidence of any type of oversight or enforcement activity on the 15-passenger van. Postcrash, the FMCSA conducted a focused investigation and determined that the van operation failed to comply with the *FMCSRs*. The FMCSA cited the operation for the following:

- Failure to register for a USDOT number.
- Failure to comply with any driver qualification requirements.
- Failure to comply with any of the HOS regulations and those pertaining to the prohibition of fatigued operation of a CMV.
- Failure to comply with vehicle maintenance or inspection requirements.
- Operation of a CMV without being properly licensed.

As a result of its investigation, the FMCSA issued an imminent hazard order, which placed the operation out of service.

The DOL–WHD also investigated violations of the MSPA. The type of operation being conducted by the van driver and his family is often referred to as illegal “raitero” activity.[70] Generally, raitero refers to a person—typically a field worker—who, for a fee, transports AG workers both to and from the work site. The workers are charged a daily roundtrip fee, with the specific amount usually contingent on the distance traveled. Raitero and carpool operations are legal unless the amount charged each worker exceeds the actual cost of providing the transportation. In such cases, the raitero is considered an FLC; must be registered with the DOL; and is responsible for complying with the registration, transportation safety, driver licensing, and insurance requirements of the MSPA.

[70] “Raitero” is the Spanish word for a person who charges a fee for providing a ride to work.

2 Analysis

2.1 Introduction

The St. Marks crash involved a 1979 Blue Bird bus transporting AG workers and a 2005 Freightliner truck-tractor with an enclosed semitrailer. The 56-year-old bus driver was traveling south on SR-363, did not respond to a stop sign and flashing red traffic control beacons, and continued straight through the intersection, directly into the path of the truck-tractor—which was traveling west on US-98. The fuel tank on the truck-tractor was breached, and a postcrash fire ensued. As a result of the crash and fire, the truck driver and three bus passengers died. The bus driver and 28 passengers sustained injuries of varying degrees. A passenger in the sleeper berth of the truck received minor injuries.

This analysis discusses the dynamics of the crash (section 2.2) and evaluates the following:

- Bus driver performance (section 2.3)
- AG worker transportation safety (section 2.4)
- Intersection safety (section 2.5)
- Heavy truck fuel tank integrity (section 2.6)
- Occupant protection (section 2.7).

The NTSB conducted a comprehensive review of the circumstances that led to the St. Marks crash. As a result of its investigation, the NTSB established that the following factors did not contribute to the cause of the crash:

- ***Driver qualifications:*** Both the bus driver and the truck driver held current CDLs with appropriate endorsements for the vehicles they were operating.
- ***Driver cell phone distraction:*** A review of both drivers' cell phone records indicated that the phones were not in use at or near the time of the crash.
- ***Driver medical conditions:*** The bus driver had hypertension, which caused no chronic or acute symptoms; he was taking medication to treat the condition. The truck driver had no history of medical issues and was reported to be in good health by his passenger, though autopsy findings revealed that he had evidence of severe coronary artery disease without any evidence of previous heart attack or other damage to his heart muscle. However, it is unlikely that the bus driver's high blood pressure or the truck driver's undiagnosed heart disease contributed to the crash.
- ***Bus driver alcohol or other drug use:*** Blood drawn from the bus driver after the crash contained no evidence of alcohol or other tested-for drugs.

- ***Truck driver fatigue:*** Based on a review of the truck driver's work and rest schedule, time awake, and time on task, he was likely not fatigued at the time of the crash.

- ***Vehicle mechanical condition:*** Although the bus driver told NTSB investigators 8 days after the crash that he applied the brakes and they did not work, this statement conflicted with the information he provided on the day of the crash. In his sworn statement to the FHP, he reported experiencing no mechanical problems and not applying the brakes. Based on the NTSB postcrash examination of the bus, the lack of physical evidence of any type of brake application, the video evidence showing no slowing or evasive steering, and the bus driver's sworn statement provided immediately after the crash, there is no evidence to suggest that any pre-existing mechanical conditions caused or contributed to the crash. Further, NTSB investigators found no evidence of any mechanical problems with the truck-tractor that would have contributed to the crash.

- ***Truck motor carrier operations:*** Verity Van Lines, Inc., was found to be in compliance with the *FMCSRs*, and had established policies, procedures, and safety management controls in place to reduce the risk of crashes.

- ***Weather:*** The weather was clear, there was no precipitation at or near the time of the crash, and the roadway was dry.

The NTSB, therefore, concludes that none of the following were factors in the crash: (1) driver qualifications to drive a CMV, (2) driver distractions due to cell phone use, (3) medical condition of either driver, (4) bus driver impairment by alcohol or other drugs, (5) truck driver fatigue, (6) mechanical condition of either vehicle, (7) truck motor carrier operations, or (8) weather.

In examining the truck driver's possible impairment by drugs or alcohol at the time of the crash, investigators relied on toxicology testing of available tissue specimens. Toxicology testing found 0.084 g/dL of ethanol in the liver tissue.[71] Additional testing performed at the request of the NTSB found 0.088 g/dL of ethanol in the liver sample and 0.092 g/dL of ethanol in the kidney sample. No drugs were detected in any of the samples tested. When ingested, alcohol rapidly becomes dispersed throughout body tissues. Intoxication is indicated if the testing result represents the driver's antemortem blood concentration of ethanol. However, it is not possible to determine how much of the identified ethanol in the liver and kidney specimens tested came from ingestion or from postmortem production. Therefore, the NTSB concludes that though ethanol was detected in the truck driver's liver and kidney tissue specimens, it is possible that its presence was the result of postmortem production of ethanol.

Emergency responders arrived on scene within 7 minutes of the crash. A multiagency response ensured efficient triage of the injured, fire suppression, and evacuation of injured bus occupants to local hospitals. Although the extrication of a few bus passengers was delayed due to concern over downed and low-hanging utility lines, the delay did not contribute to the severity of

[71] The blood alcohol concentration limit for commercial drivers is 0.04 g/dL. Based on interviews with the truck passenger, the driver consumed two to three beers between 6:00 and 8:00 p.m. on the night before the crash.

the injuries. The NTSB concludes that the emergency response and fire suppression efforts were timely and effective.

2.2 Crash Reconstruction

NTSB investigators reconstructed the collision sequence to obtain a better understanding of the actions taken by the bus and truck drivers, the injuries to bus passengers, and the causes of vehicle damage.

2.2.1 Video and Physical Evidence

Examination of the roadway physical evidence showed no indication of preimpact braking or evasive steering action by either the bus driver or the truck driver immediately prior to the crash. Most of the roadway evidence was deposited by the truck-tractor semitrailer and consisted of tire friction marks that arced in a southwesterly direction toward its position of final rest.

In addition to the roadway evidence, investigators analyzed security camera video footage obtained from a gas station located at the southeast corner of the intersection. Individual video frames were analyzed based on a model of the camera optics.[72] From this analysis, the speed of the bus was estimated as 46 ±2 mph and the speed of the truck as 44 ±4 mph. The video footage shows the bus traveling south on SR-363, proceeding past the stop sign and stop line, and crossing directly into the path of the truck-tractor, which is heading west on US-98. Less than 1 second after impact, an explosion of fire emits from the truck-tractor. Both vehicles then proceed toward the southwest corner of the intersection.

From the video study and review of physical evidence, the NTSB concludes that the bus driver failed to stop at the US-98–SR-363 intersection, which is controlled by a stop sign and flashing red traffic control beacons, and proceeded directly into the path of the truck-tractor.

2.2.2 Vehicle Dynamics

To determine the dynamics of the vehicles during the crash sequence, the NTSB conducted a vehicle dynamics study using crash simulation software.[73] In the study, the collision speed of both the bus and the truck-tractor were varied until the motion of the vehicles most closely matched the scene evidence and damage patterns. Figures 14a–14d depict several key impacts during the crash sequence in still images from the simulation, with corresponding photographs of the damage or effects.

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[72] See the video study report in the NTSB public docket for this investigation (HWY16MH019) for additional information regarding the camera calibration and speed estimates.

[73] PC-Crash, a commercially available software capable of modeling three-dimensional motion of trucks and buses, was used for the study. The software relies on an impulse-momentum collision model. For more information, see the PC-Crash website for simulations of collision and trajectory physics, accessed September 20, 2017.

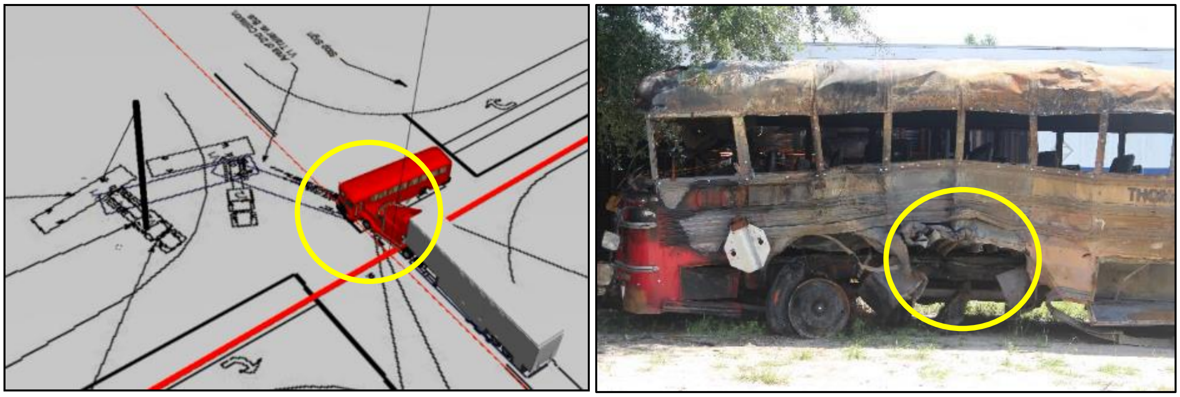

Figure 14a. Still image from simulation depicting impact of front of truck-tractor with left side of bus, behind front axle, and photograph of corresponding damage to bus.

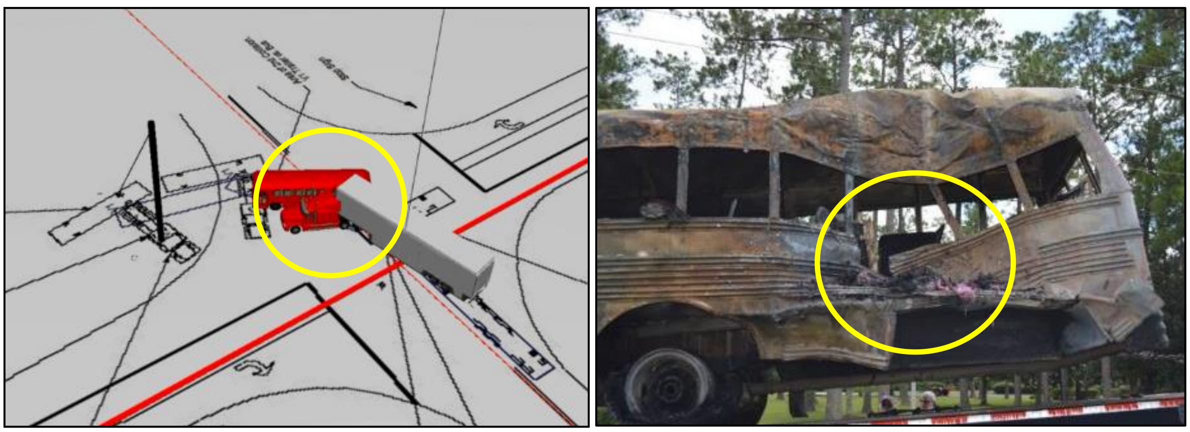

Figure 14b. Still image from simulation depicting impact of right leading edge of semitrailer with left side of bus near rear and photograph of corresponding damage to bus.

Figure 14c. Still image from simulation depicting impact of right front-loading door area of bus with utility pole guy wire and photograph of corresponding damage to bus.

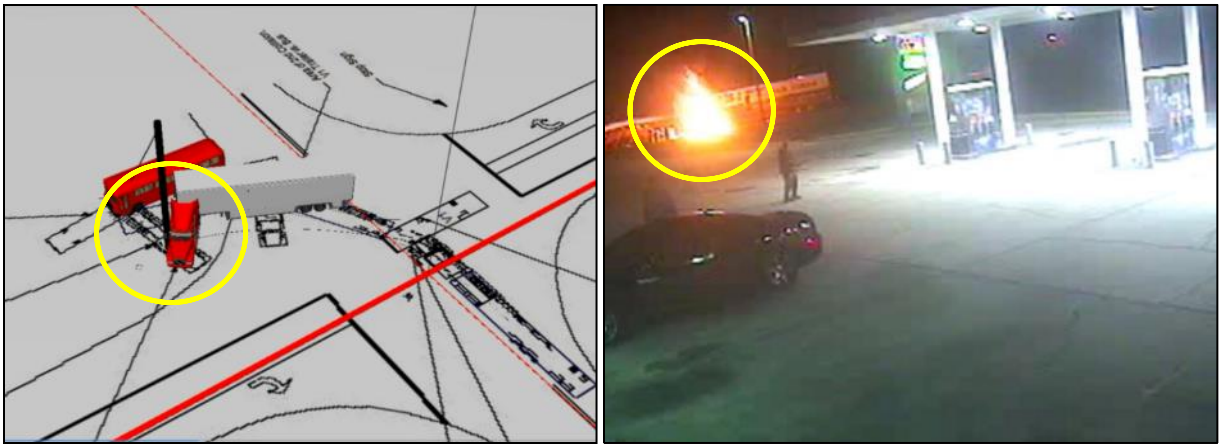

Figure 14d. Still image from simulation depicting impact of right side of truck-tractor with utility pole and video still image of vehicles at positions of final rest.

2.2.3 Truck-Tractor Precrash Dynamics and Driver Performance

Video and physical evidence and the vehicle dynamics study indicated no preimpact evasive action by either driver.[74] Using a video-estimated truck speed of 44 mph and bus speed of 46 mph, NTSB investigators conducted a time–position analysis to determine the relative positions of the vehicles as they approached the intersection. In evaluating the truck driver's performance, investigators considered environmental conditions, including the ability of the driver to see the approaching bus. As depicted in figure 15, the truck driver had a clear and unobstructed view of SR-363 to see vehicles at the stop line; however, a vacant building on the northeast corner (circled) blocked his view of vehicles on approach to the stop sign.

Figure 15. US-98 west approach to intersection with SR-363, with yellow circle denoting vacant building on northeast corner, which partially obstructs view of traffic on SR-363.

[74] The truck driver was facing flashing yellow traffic control beacons and was required by law to proceed through the intersection with caution.

Based on the time–position analysis, the truck-tractor was about 126 feet from the intersection when the bus would have first become visible. This estimated distance allowed the truck driver less than 2 seconds to react, brake, or steer to avoid a crash (figure 16). Therefore, the NTSB concludes that because of the limited sight distance available to the truck driver on his approach to the intersection, he did not have sufficient time to react and take evasive action prior to colliding with the bus.

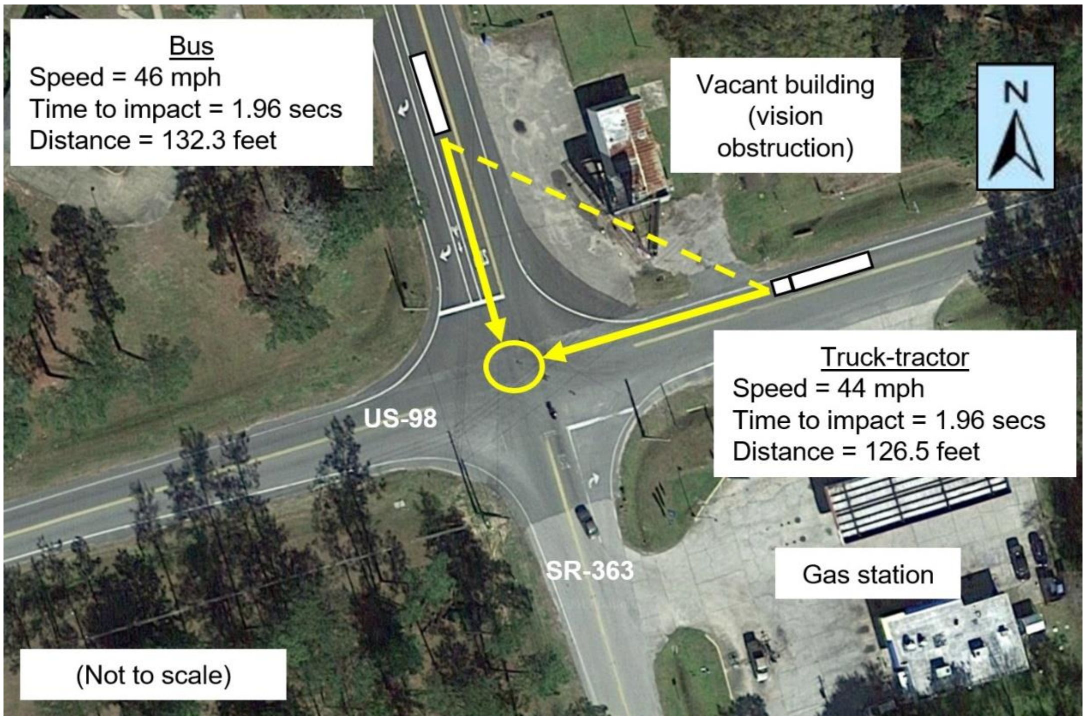

Figure 16. Aerial view of US-98–SR-363 intersection, depicting relative positions of bus and truck-tractor about 2 seconds from impact.

2.3 Bus Driver Performance

NTSB investigators reviewed the visual cues available to the bus driver on approach to the US-98–SR-363 intersection, his familiarity with the roadway, and other factors that may have contributed to his failure to stop.

2.3.1 Visual Cues

NTSB investigators completed multiple drive-throughs of the approaches to the intersection under similar dark, nighttime conditions to evaluate the presence and conspicuity of the signs, roadway markings, and traffic control devices. SR-363 is a straight approach to the crash site, with newly painted edge lines and centerlines, as well as newly milled rumble strips on the shoulder. SR-363 has no artificial lighting, and the bus driver mentioned in his interview that he had to concentrate on the roadway because of the darkness.

The roadway pavement markings are clearly visible when illuminated by headlamps, and the flashing red traffic control beacons can be seen from a distance of 2.8 miles. Additional visual cues of the approaching intersection include a "STOP AHEAD" warning sign, a stop line with "STOP" painted on the pavement, and a stop sign. Based on the observational study, the NTSB concludes that the bus driver's approach to the intersection provided sufficient visual cues and positive traffic control information for an attentive and alert driver to have recognized the intersection and the requirement to stop.

2.3.2 Familiarity With Roadway

The bus driver had never driven from Bainbridge, Georgia, to Belle Glade, Florida. According to the driver and his supervisor, the plan was to take US-27 south from Bainbridge to the Tallahassee area, where he would merge onto I-10 east. The driver used his cell phone to navigate during the first part of the trip, but he discontinued using it prior to reaching the I-10 interchange. He subsequently missed the I-10 exit and continued south on US-27 into downtown Tallahassee. After several miles, the highway turns into SR-363, which leads to St. Marks. The driver stated that he was not concerned about missing the I-10 exit, because he believed that if he continued on SR-363 he would eventually reach a route to his destination.

For the final 10 miles on approach to the intersection, SR-363 is predominantly flat, straight, and lined on both sides with trees. According to the bus driver, the roadway was very dark. He also reported that he had his high beams on and had reduced his speed to about 50 mph, because he was unfamiliar with the area.[75] On this route, the US-98–SR-363 intersection is the first unsignalized, stop-controlled intersection since the driver had mistakenly passed the US-27 exit for I-10.[76] The NTSB concludes that the bus driver was unfamiliar with the roadway environment and unaware that his route of travel on SR-363 was not taking him to his intended destination.

2.3.3 Inattention and Fatigue

The bus driver's failure to detect or respond to multiple visual cues concerning the stop ahead suggests a lapse in attention.[77] Fatigue is one factor that can lead to lapses in attention. NTSB investigators reviewed the driver's work and rest schedule, work environment, payroll records, quality of sleep, and time on task. He had worked in the corn fields for 22 of the 28 days leading up to the crash, in addition to performing his duties as a driver. Two men who worked alongside him described the work as very grueling, because it involved building boxes all day in

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[75] Because of the damage to the bus and headlamp assemblies, the NTSB did not have sufficient forensic evidence to determine if the high beams had been activated at the time of the crash.

[76] (a) An unsignalized intersection is a junction of two or more public roads at which no highway traffic signal controls the right-of-way for motorists, bicyclists, and pedestrians. This designation includes a stop sign-controlled intersection, a yield sign-controlled intersection, and an uncontrolled intersection in which no regulatory signs control approaches. (b) The bus driver traveled through more than 20 signalized intersections after passing the I-10 exit. Stop sign running is often associated with long sections of moderate-volume highways that abruptly stop at a major crossroad (FHWA 2011b).

[77] As noted in section 2.1, drug or alcohol impairment, medical impairment, cell phone distraction, and vehicle mechanical condition are excluded as causal factors in the crash.

the hot sun. During the interview with NTSB investigators, the driver said, "I'm always sleepy. You know, I am under the sun and I wake up very, very early, so I'm always sleepy."

According to the bus driver, on the days prior to leaving Bainbridge, he would normally go to bed at 8:00 p.m. and awake at 4:00 a.m. However, on July 1, the night before his return trip to Belle Glade, he went to bed at 9:00 p.m. and awoke at 1:30 a.m.—which provided only 4.5 hours of sleep opportunity, placing him at increased risk of a crash (Tefft 2016). This time—1:30 a.m.—was also about 2.5 hours earlier than he was accustomed to waking. Additionally, though the crash occurred at a time of day when the driver would normally be awake, he was operating during a circadian dip in cognitive and physiological performance (Smiley 2015).

Lack of sleep and driving during a circadian dip might have left the driver feeling fatigued and have affected his alertness, judgment, or visual scanning behavior (Williamson 2007). Sleep deprivation can reduce the ability to detect information in the driving environment and, over the course of a monotonous drive, compromise a driver's useful visual field. With a reduction in visual field, a driver is slower to detect critical signals or information and may not perceive them at all, which may ultimately result in a crash (Roge and others 2002). The NTSB concludes, therefore, that the effects of fatigue caused by acute sleep deprivation and circadian factors likely contributed to the bus driver's lack of response to visual cues indicating the required stop at the intersection.

2.4 Agricultural Worker Transportation Safety

The NTSB investigation of this crash and other recent crashes involving the transportation of AG workers emphasizes the need for more effective oversight of drivers and farm labor vehicles (FLV).[78] Because of the demographics of the farm labor community, many AG workers do not have a driver's license and rely on transportation arranged by the AG employer, FLCs, or carpool operations. Workers are often transported to farming locations in large numbers by bus, van, or heavy truck, and the consequences of unsafe operations leading to a single crash can be catastrophic. It is essential that federal and state oversight agencies collaborate in both focused and targeted enforcement of safety regulations. Furthermore, the lack of knowledge among motor carriers and FLCs as to the legal requirements for safe operation of FLVs demonstrates a need for additional outreach and education in the agricultural community. The following sections address these safety issues and recommend actions to improve the safe transportation of farm workers.

2.4.1 St. Marks Crash

Billy R. Evans was responsible for motor carrier operations related to the bus driver and the FLV involved in the crash. The company is an authorized motor carrier registered with the FMCSA and is also licensed as an FLC with the DOL.

In a review of carrier operations, NTSB investigators determined that Billy R. Evans was noncompliant with regulations and was fostering an environment that was not conducive to the safe transportation of AG workers. The company had no written safety policies, no drug and

[78] The DOL–Bureau of Labor Statistics reports 56 AG workers killed in highway crashes in 2015, but this figure likely does not represent the actual number of fatalities because it relies on employer reports.

alcohol testing program, no in-service training, and no program for monitoring on-road driving actions or hours of service. Additionally, Billy R. Evans had no program to systematically inspect or repair any of its vehicles.

2.4.1.1 Bus Driver Hiring Process. Billy R. Evans hired the bus driver in April 2016, less than 3 months before the crash. During the hiring process, the carrier did not conduct a background check and did not validate the driver's license history with the Florida Department of Highway Safety and Motor Vehicles. The only hiring requirement placed on the bus driver was for him to provide a CDL with a "P" endorsement authorizing him to transport passengers. Title 49 *CFR* 391.23(a) requires a motor carrier to conduct investigations and inquiries with respect to each driver it employs and to consider the driver's accident record and any evidence that the driver has violated motor vehicle laws. In making hiring decisions, federal regulations direct carriers to give great weight to any past operation that indicates a disregard for public safety.

If Billy R. Evans had done due diligence and checked the bus driver's employment history, management would have determined that he had been terminated because of repeated unsafe driving behaviors. While he was working for Academy Bus from July 2014 through April 2015, the company's in-vehicle driver monitoring system recorded numerous safety violations. On three instances, the driver ran a stop sign or traffic signal light; on two occasions, he did not fully stop at a stop sign and committed a rolling violation; and he once stopped substantially past the intersection limit line. After multiple counseling sessions, Academy Bus terminated the driver for being a risk to its operations. Additionally, a background check would have revealed that when the driver was employed by Pero Family Farms Food Company from January to April 2016, he had been involved in an intersection crash while transporting migrant workers.

Billy R. Evans's failure to check the bus driver's employment history or driving record prevented it from making an informed hiring decision and from determining whether the new hire posed a safety risk.

2.4.1.2 HOS Compliance and Fatigue Management. Billy R. Evans had no program in place for monitoring driver hours of service. Title 49 *CFR* 395.8 requires motor carriers to ensure that each driver maintains a daily record-of-duty status detailing the hours driven and the hours spent off duty. The carrier failed to produce any logbooks or time sheets for the bus driver. Billy R. Evans management told NTSB investigators that it did not require or maintain logbooks or time records for any drivers because it thought logs were required only if trips exceeded 8 hours.

Many motor carriers provide routine training to drivers on the dangers of operating a motor vehicle while fatigued. Some employers have enacted structured fatigue management programs that include policies, procedures, and training seminars. Billy R. Evans provided no in-service training and did not monitor the fatigue of the bus driver. Based on its review of motor carrier operations, the NTSB concludes that Billy R. Evans failed to follow adequate safety practices and to exercise oversight of its drivers and vehicles.

2.4.2 Little Rock and Ruther Glen Crashes

2.4.2.1 Little Rock. In this November 6, 2016, crash, the 28-year-old driver had been on duty for about 14 hours when the motorcoach transporting migrant AG workers departed the I-40 west traffic lanes at a shallow angle and collided with a concrete barrier and a highway overpass bridge column. NTSB investigators found no evidence of evasive braking or steering maneuvers. Although the driver was alternating driving shifts with a codriver, cell phone records indicate that he was not always resting when not driving. His work schedule records show that he worked at a farm in Carleton County, Michigan, and averaged 11.5 hours of farm labor nearly every day. Given that the crash occurred at 12:55 a.m.—a time when people are biologically predisposed to sleep, the driver's cumulative hours on duty without sufficient rest, and the shallow departure angle from the travel lanes without evasive input, it is likely that he was fatigued.

The operator of the motorcoach, Vasquez Citrus and Hauling, did not monitor the driver's hours of service, nor did the driver maintain a record-of-duty status as required by federal regulations. When NTSB investigators interviewed Vasquez management, it advised that no one monitored hours of service because it believed that agricultural operations were exempt from regulations. A further review of operations showed that the company had no written safety policies, no training program for drivers, and no drug or alcohol testing program. Additionally, a review of roadside inspection data showed driver and vehicle OOS rates much higher than the national level.

2.4.2.2 Ruther Glen. On June 18, 2016, a 15-passenger van transporting migrant AG workers departed the I-95 north travel lanes onto the left shoulder, swerved to the right across all three lanes of travel, struck the left rear side of a passenger vehicle, and overturned before coming to rest on the right shoulder. The van driver told NTSB investigators that he "didn't sleep very well" the previous night. Additionally, the driver's sleeping conditions were less than optimal; he slept on the floor of a rental property that he shared with 13 other workers. At the time of the crash—12:35 a.m.—the 50-year-old driver had been awake and on duty for about 17.5 hours and had traveled 272 miles. During a postcrash interview, he told investigators that he "felt sleepy and fell asleep just before the accident."

At the time of the crash, the van operation did not have operating authority from the FMCSA, nor did it have liability insurance for the vehicle. The driver did not hold a valid driver's license or DOT medical certificate. A postcrash inspection of the van revealed that nine seat belts had previously been cut out and removed, and four others were tied and twisted in knots. The missing and inoperable seat belts contributed to the fatalities and injuries.

The NTSB concludes that driver fatigue and the failure of the motor carriers to follow adequate safety practices were key factors in both the Little Rock, Arkansas, and Ruther Glen, Virginia, crashes.

2.4.3 Federal Oversight

2.4.3.1 FMCSA New Entrant Safety Assurance Program and Safety Recommendations. The FMCSA oversight of Billy R. Evans prior to the St. Marks crash was very limited. Its only contact with the carrier occurred on April 28, 2005, when it conducted a new entrant safety audit. There was no further interaction with the carrier for the following 11 years.

The FMCSA uses data from roadside inspections, crash reports, and law enforcement contacts to prioritize carriers for additional scrutiny and CRs. Billy R. Evans did not receive sufficient federal oversight because of the following factors:

- It did not have enough roadside inspections or enforcement contacts to be prioritized for intervention by the FMCSA.
- It failed to keep its registration current and falsely described its operations as being intrastate, which falls outside the primary focus of the FMCSA.
- It was engaged in farming operations and was exempt from many of the *FMCSRs*.

Given the limited resources at the FMCSA, it is understandable that the agency had limited contact with the carrier. The NTSB is concerned, however, that Billy R. Evans passed the FMCSA new entrant safety audit and received operating authority with no safety management controls in place.

The purpose of the new entrant safety assurance program, established in 2003, is to provide educational and technical assistance to the new entrant and to assess the carrier's safety performance and the adequacy of its basic safety management controls.[79] Billy R. Evans passed the new entrant audit in April 2005, despite numerous deficiencies and insufficient knowledge in such areas as the following:

- Maintaining driver qualification files and reviewing employment histories
- Maintaining a drug and alcohol testing program
- Making and submitting records-of-duty status
- Conducting periodic inspections of vehicles
- Maintaining vehicle maintenance files.

After sending Billy R. Evans a letter "encouraging" it to take prompt action to comply with regulations, the FMCSA conducted no followup to ensure that any of these safety deficiencies were corrected, nor did it provide the results of the audit to the DOL–WHD, which

[79] A review of new entrant safety audit data indicates that 39,919 audits were completed in fiscal year 2015, with an 84.1 percent pass rate; and 38,101 audits were completed in fiscal year 2016, with an 88.3 percent pass rate (FMCSA 2016).

also has oversight responsibilities for the carrier. In a postcrash CR, the FMCSA found Billy R. Evans to be in noncompliance with the *FMCSRs* and issued an imminent hazard order. Nearly all of the postcrash violations cited in the order were the same safety deficiencies identified in the new entrant safety audit.

The fact that Billy R. Evans management failed to implement any safety programs during its entire period in business suggests that the new entrant safety assurance program—and safety audit letter encouraging compliance—did not effectively prevent a poorly prepared new operator from participating in interstate operations. The only contact the FMCSA may have with many motor carriers—particularly those engaged in farming operations and the transportation of migrant workers—is when they file for interstate operating authority and are required to pass a new entrant safety audit. It is imperative, therefore, that new entrant screening consider the prospective carrier's safety processes, which should include procedures to identify and manage safety risks, programs to prevent and mitigate risks, and measures to continually evaluate and enhance safety. The NTSB concludes that the FMCSA missed the opportunity provided by the new entrant safety assurance program to ensure that Billy R. Evans had a programmatic commitment to safety, and the carrier entered the AG worker transportation industry without demonstrating an understanding of its safety responsibilities.

In its report on a 2002 crash in Loraine, Texas, the NTSB made the following safety recommendation to the FMCSA (NTSB 2003):

> Require all new motor carriers seeking operating authority to demonstrate their safety fitness prior to obtaining new entrant operating authority by, at a minimum: (1) passing an examination demonstrating their knowledge of the *Federal Motor Carrier Safety Regulations*; (2) submitting a comprehensive plan documenting that the motor carrier has management systems in place to ensure compliance with the *Federal Motor Carrier Safety Regulations*; and (3) passing a Federal Motor Carrier Safety Administration safety audit, including vehicle inspections. (H-03-2)

The FMCSA has taken some steps to improve and enhance the new entrant safety assurance program. In August 2009, it published an Advance Notice of Proposed Rulemaking; and, in 2014, it convened a series of listening sessions to elicit public input. The agency is currently considering nonregulatory options for improving the new entrant program. Safety Recommendation H-03-2 is classified "Open—Acceptable Response."

In 2011, during the investigation of a multifatality bus crash in Doswell, Virginia, the NTSB concluded that a structured process such as the safety management cycle would help new entrant carriers demonstrate their intention to provide a positive safety culture. As such, the NTSB made the following safety recommendation to the FMCSA (NTSB 2012):

> As a component of your new entrant safety audits, review with each new entrant motor carrier a structured process, such as the Safety Management Cycle, to (1) identify the root cause of safety risks and (2) maintain an effective safety assurance program. (H-12-31)

In response to this recommendation, the FMCSA has updated its Compliance, Safety, Accountability (CSA) website to include information on the safety management cycle. The FMCSA has also incorporated the safety management cycle into CRs, but it has not incorporated it into the new entrant safety program. Safety Recommendation H-12-31 is classified “Open—Unacceptable Response.”

The NTSB continues to maintain that new entrants should be required to demonstrate an understanding of the safety responsibilities codified in the *FMCSRs* and have a systematic improvement process in place to reduce crash risk. Because such knowledge is particularly important before beginning passenger transportation services, the NTSB reiterates Safety Recommendations H-03-2 and H-12-31 to the FMCSA. In addition, Safety Recommendation H-03-2 is reclassified “Open—Unacceptable Response.”

2.4.3.2 DOL–WHD Program and Safety Recommendation. The MSPA authorizes the DOL to investigate and remedy violations involving migrant and seasonal workers. Prior to the St. Marks crash, the DOL–WHD had limited interaction with Billy R. Evans. On June 22, 2016, less than 2 weeks prior to the crash, it had completed a spot check of the carrier’s operations in Bainbridge but failed to recognize that the 1979 Blue Bird bus was not authorized for the transportation of migrant workers. The investigator did not document the visit and did not require the carrier to produce vehicle registration information. Likewise, with regard to the Little Rock and Ruther Glen crashes, the DOL–WHD had had no previous interactions with the carriers to ensure compliance with the MSPA.

In addition to protecting farm workers under the provisions of the MSPA, DOL–WHD investigators are responsible for enforcing federal regulations related to wages, family and medical leave, consumer credit, fair labor standards, and child labor. Ensuring the safe transportation of AG workers requires knowledge of vehicle safety standards, medical requirements for drivers, driver qualifications, and HOS regulations, as specified in subpart D of 29 *CFR* Part 500.

FMCSA investigators have extensive training in issues directly related to transportation safety. However, DOL–WHD investigators have no formal training in truck or bus inspections, and most do not have the technical expertise to assess the safe mechanical operation of a CMV. With a workforce of fewer than 1,400 employees, the DOL–WHD oversees 9,800 FLCs while enforcing the many other MSPA regulations. The safe transport of migrant workers is only one element of its MSPA responsibilities.

From 2010 to 2013, 6,119 DOL–WHD investigations focused on agriculture-related issues, with a relatively small number of cases related to transportation safety (Farmworker Justice 2015). During this same time, 349 employers were found to be transporting workers without a certificate of authorization, 264 employers failed to ensure that drivers had valid licenses, and 349 employers failed to provide safe transport vehicles. The majority of these enforcement actions were reactive, in response to complaints or crashes or incidents, with little evidence of proactive data-driven strategies to prevent crashes. The NTSB concludes that the DOL–WHD failed to conduct adequate oversight of Billy R. Evans operations prior to the crash and likely has insufficient resources, trained investigators, or proactive strategies to adequately ensure the safe transportation of migrant workers.

The DOL–WHD has identified AG workers as among the most vulnerable groups in the work force (DOL 2013). As recent catastrophic crashes have shown, part of this vulnerability is related to unsafe transportation by agricultural employers and FLCs. With an interest in improving the effectiveness of DOL–WHD oversight of migrant worker transportation safety, the NTSB recommends that the DOL audit the WHD oversight processes related to the safe transportation of migrant workers to determine, at minimum, if adequate resources are available to enforce the motor vehicle safety provisions of the MSPA; if investigators are sufficiently trained to enforce transportation-related regulations; and if additional data-driven strategies are available to better focus limited enforcement resources. Once the audit is complete, require the WHD to resolve any identified issues.

2.4.3.3 Federal Agency Collaboration and Safety Recommendations. Both the FMCSA and the DOL–WHD have oversight responsibilities for CMVs engaged in the transportation of AG workers. Many of the FMCSRs and MSPA regulations overlap, without distinguishing which agency has enforcement responsibility. Furthermore, each agency collects motor carrier and FLC data that are not routinely shared. For example, when the FMCSA conducted a new entrant safety audit of Billy R. Evans, numerous safety deficiencies were identified, but this information was not passed on to the DOL–WHD, which could have focused increased oversight on the carrier. Likewise, prior to the Little Rock crash, the FMCSA CSMS had identified Vasquez Citrus and Hauling as an at-risk carrier with safety deficiencies related to the maintenance of vehicles, unsafe driving operations, and crash propensity. This information was not forwarded to the DOL–WHD, which could have directed additional attention to the company.

The NTSB concludes that the FMCSA and the DOL–WHD do not routinely collaborate regarding enforcement responsibilities and operations, nor have processes been established for the delivery of safety-critical information related to at-risk AG worker transportation carriers. To improve the coordination and sharing of information, the NTSB recommends that the FMCSA work with the DOL to outline enforcement responsibilities and to establish a process for the routine sharing of safety-critical information, such as safety measurement system data, CR results, and new entrant safety audit information. The NTSB issues a corresponding recommendation to the DOL.

2.4.4 Roadside Enforcement Challenges

2.4.4.1 Federal–State Collaboration. In addition to CRs, roadside enforcement plays a vital role in ensuring that only compliant and safe vehicles operate on the nation's roadways. Enforcement provides not only a deterrent but also a source of valuable data to identify those carriers that pose the greatest risk. No CSMS scores were available for Billy R. Evans because of its limited number of roadside inspections. Without inspection data, the FMCSA has insufficient information to prioritize a carrier for intervention.

There are several obstacles to federal and state authorities in conducting enforcement operations. For example, the *FMCSRs* include exemptions for farmers and for operations classified as "exempt motor carrier."[80] Because of these exemptions, roadside inspectors rarely inspect farm operations or vehicles. Additionally, statutory roadblocks limit the inspection of motorcoaches and buses in transit or loaded with passengers.[81] Van operations—though representing a smaller segment of passenger vehicles—are rarely inspected by state or local authorities except during focused safety campaigns, such as prom season, or in jurisdictions that have oversight programs for airport shuttles. Because of these exemptions and enforcement limitations, it is difficult to detect illegal van operations such as in the Ruther Glen case.

To overcome these obstacles, some states have assigned dedicated enforcement personnel to work in agriculturally significant areas to ensure compliance with state and federal laws. For example, in the California Highway Patrol (CHP) safety and farm education (SAFE) program, CHP officers conduct regularly scheduled inspections throughout the farming regions to annually certify FLVs. SAFE provides opportunities to ensure that drivers are properly licensed; to notify drivers about safety defects that need correction; and, if necessary, to take enforcement action to prevent unsafe vehicles and drivers from transporting passengers. Enforcement strike forces are deployed throughout the peak harvest season to ensure that FLVs comply with registration and safety laws. Strike force operations have been found to be particularly effective during the morning and afternoon hours in areas where FLVs use the highway to transport farm workers to and from AG fields.

During 2014, CHP stopped 1,599 FLVs for moving or equipment violations on public highways. In the same year, eight officers assigned to the SAFE program in the Central Valley certified 334 FLVs, issued 2,841 enforcement citations, arrested 19 impaired drivers, and placed 37 certified and 42 uncertified FLVs out of service (GHSA 2015). In the 3 years prior to creation of the program, an average of 62 FLV collisions and more than six fatalities occurred annually. The number of collisions dropped 73 percent to a total of 17 FLV crashes during the first year of the SAFE program. Additionally, there were no fatalities in the first 3 years after program implementation (CHP 2002).[82] The NTSB concludes that targeted roadside enforcement campaigns in AG areas during peak harvest seasons can be effective in removing unsafe FLVs and drivers from the roadways.

2.4.4.2 Safety Recommendation. The FMCSA and the DOL–WHD have limited resources to enforce regulations for the transportation of AG workers. It is essential that the two agencies leverage resources to support state law enforcement FLV safety programs. The Motor Carrier Safety Assistance Program (MCSAP) is an FMCSA grant program that provides financial assistance to states to reduce the number and severity of crashes involving CMVs. However,

[80] Title 49 *CFR* 390.5 defines an exempt motor carrier as one engaged in transportation exempt from economic regulation by the FMCSA under 49 *United States Code* (*USC*) 13506. An exempt motor carrier includes a person who drives a CMV that is controlled and operated by a farmer as a private motor carrier to transport agricultural products, farm machinery, or farm supplies to or from a farm—and is not being used as a for-hire motor carrier, but is being used within 150 air-miles of the subject farm.

[81] Per 49 *USC* 31102(c)(2)(W), the DOT may approve state motor carrier assistance programs only when inspection of vehicles "transporting passengers for a motor carrier is conducted at a bus station, terminal, border crossing, maintenance facility, destination, or other location where a motor carrier may make a planned stop (excluding a weigh station)."

[82] In 2015, the CHP SAFE program received a special achievement award for notable accomplishments in the field of highway safety by the Governors Highway Safety Association (GHSA 2015).

additional directed enforcement efforts are necessary to decrease the number of crashes involving unsafe vehicles and drivers transporting AG workers. The NTSB recommends that the FMCSA develop and implement a data-driven targeted enforcement plan, in collaboration with state MCSAP partners, that incorporates recurring targeted roadside enforcement efforts in high-density agricultural regions during peak harvest seasons.

2.4.5 Managing Driver Fatigue

2.4.5.1 AG Worker-Specific Issues. The drivers involved in the St. Marks, Little Rock, and Ruther Glen crashes were each likely impaired by the effects of fatigue. Each driver not only performed driving duties but also worked long, strenuous hours doing farm work. In a review of the motor carrier operations and safety oversight of the involved drivers, NTSB investigators found no indication that the carriers monitored the drivers' work and rest schedules or took any actions to mitigate potential risks associated with driver fatigue. Both Billy R. Evans and Vasquez Citrus and Hauling management were under the mistaken assumption that they were exempt from having to monitor driver hours of service. The NTSB concludes that some motor carriers and FLCs do not manage the fatigue of company drivers transporting AG workers, thereby placing workers—and the motoring public—at unnecessary risk of being injured in a crash.

2.4.5.2 Safety Recommendation. The NTSB has a long history of making safety recommendations to address fatigue as it affects commercial drivers. We have called for science-based HOS regulations, improved screening and treatment of sleep disorders, in-vehicle technologies to reduce fatigue-related crashes, and comprehensive fatigue management programs tailored to the specific work environment. Fatigue management programs commonly address scheduling policies and practices, employee education, task/workload issues, rest environments, napping, medical screening and treatment, fatigue monitoring technologies, and commuting. Managing the fatigue of AG workers requires special consideration of the arduous work, which typically occurs in hot and humid weather conditions.

The MSPA provides safeguards for migrant AG workers in their interactions with agricultural employers and FLCs but primarily focuses on motor vehicle safety standards and registration/licensing requirements. The act contains no requirement that employers or FLCs ensure that workers are rested before driving. Moreover, in a review of the DOL–WHD website and training material, NTSB investigators found no information for agricultural employers on how to manage fatigue.

The DOL–WHD routinely participates in outreach events, including compliance assistance workshops. To reduce crashes involving the transportation of AG workers, agricultural employers and FLCs must become more aware of the dangers of driving while fatigued and the benefits of fatigue management. Because the DOL–WHD has frequent interactions with the agricultural community, and all FLCs are required to register with the DOL, the NTSB recommends that it develop and disseminate guidelines and training material for agricultural employers and FLCs on the dangers of driving while tired and on strategies for managing driver fatigue.

2.4.6 Development of Best Practices Guidelines

2.4.6.1 State Programs. Several states have developed programs aimed at improving transportation safety for AG workers. These programs include the following:

- ***Michigan Farmer's Transportation Guidebook:*** Recognizing a lack of information on the agricultural use of commercial vehicles, the Michigan Farm Bureau and the Michigan State Police (MSP) developed a farmer's transportation guidebook (MSP 2016). The guide provides information on driver qualification and standards, HOS compliance, and vehicle standards and registration.

- ***Florida Best Practices Incentive Program for FLCs:*** In addition to deploying 16 investigators in agriculturally significant areas across the state, the Florida DBPR has also taken steps to establish a best practices program for FLCs. To receive a "best practices" designation, the FLC must be properly registered, have no major violations in the past 5 years, have a limited number of minor violations, submit to an initial field inspection by the DBPR, and have followup inspections every 2 years.[83]

- ***California SAFE Program:*** This program, established in 2000, places 20 uniformed officers in full-time work in enhanced inspection and enforcement, public education and awareness, bilingual engagement with the Hispanic community, media outreach, and educational seminars (CHP 2002). During the first year of SAFE, farm labor collisions decreased by 73 percent, and fatal crashes were eliminated for the first time in 8 years.

- ***California Agricultural Industries Transportation Services (AITS):*** In conjunction with SAFE, California launched AITS in 2001 to establish a comprehensive vanpool program in the Central Valley (Kings County Area Public Transit Agency [KCAPTA] 2009). The project provides qualified AG workers with the means to transport themselves and others to work in shared ride vanpools.

The NTSB concludes that many states and local jurisdictions have developed programs to improve transportation safety for migrant AG workers, and the sharing of best practices would improve safety across the country.

2.4.6.2 Safety Recommendations. Based on shared federal responsibilities and the success of model state programs, the NTSB recommends that the DOL work with the FMCSA to develop and disseminate guidelines for state oversight agencies on how to improve transportation safety for migrant and seasonal AG workers. These guidelines should include, at minimum, an overview of regulatory responsibilities, strategies for enhanced inspection and enforcement, suggestions for effective outreach and educational campaigns, and options for alternative transportation services. The NTSB issues a corresponding recommendation to the FMCSA.

[83] The Florida program is expected to be implemented in 2018, and the DBPR website will maintain a list of the "best practices" FLCs.

2.4.7 Motorcoach Industry Outreach

2.4.7.1 Potential for Industry–AG Worker Collaboration. Migrant workers require safe transportation to and from farm locations. Safety professionals in the bus industry—represented by the American Bus Association (ABA) and the United Motorcoach Association (UMA)—could partner with agricultural employers, FLCs, or the migrant worker population. Moreover, the ABA Hispanic Motor Coach Council, which represents motor carriers in the southern border states, could increase communication and advocate ridership with the migrant AG worker population. The NTSB concludes that both the ABA and the UMA are in a unique position to provide safe transportation services through outreach and engagement with agricultural employers, FLCs, and the migrant worker population.

2.4.7.2 Safety Recommendation. Based on the potential benefits of collaboration between the bus industry and migrant AG workers, the NTSB recommends that the ABA and the UMA initiate an outreach campaign to agricultural employers, FLCs, and the migrant worker community to offer access to safe, reliable, and authorized motor carriers to meet their transportation needs.

2.5 Intersection Safety

2.5.1 FDOT Initiatives

2.5.1.1 Safety Improvements and Transverse Rumble Strips. FDOT had taken numerous steps to improve the safety of the US-98–SR-363 intersection prior to the crash. These improvements included the following:

- Installing flashing intersection control beacons.
- Adding a "CROSS TRAFFIC DOES NOT STOP" plaque to the stop sign.
- Augmenting the stop sign with a 24-inch-wide stop line.
- Posting a "STOP AHEAD" sign.
- Establishing exclusive right-turn lanes on both the north and south approaches to minimize delays at the intersection.
- Installing transverse rumble strips on both the north and south approaches to the intersection.

Many of these safety improvements, particularly the placement of transverse rumble strips, were made to reduce crashes involving motorists on SR-363 failing to stop at the approaching intersection. Unfortunately, at the time of the crash, the transverse rumble strips were not in place due to an ongoing pavement improvement project. The rumble strips were reinstalled on July 8, 2016—6 days after the crash. Postcrash testing of the newly installed rumble strips revealed that—though there was likely no discernible sound level increase when the bus traversed the strips—the haptic vibrations and visual cues were significant. Had the transverse rumble strips been in place on July 2, they would have provided the inattentive bus driver with additional sensory cues of the approaching intersection. The construction contract plans contained no provisions for the use of temporary strips during the pavement improvement project. The NTSB concludes that had FDOT reinstalled the transverse rumble strips before the crash or used temporary transverse rumble strips as an interim measure, the strips might have alerted the bus driver of his approach to the stop-controlled intersection ahead.

2.5.1.2 Safety Recommendation. Each year, FDOT updates its *Standard Specifications for Road and Bridge Construction* (FDOT 2016). The specifications include requirements for construction and materials, including information on traffic control devices and numerous temporary safety devices, such as guardrails, barriers, channelizing devices, and crash cushions. However, they do not include guidance on the use of temporary transverse rumble strips during improvement projects. Construction projects should include a plan either to use temporary devices as an interim measure or to reinstall permanent safety devices in a timely manner. Therefore, the NTSB recommends that FDOT revise its *Standard Specifications for Road and Bridge Construction* to include guidance on the timely reinstallation of permanent transverse rumble strips during construction projects or the use of an alternative safety treatment, such as temporary rumble strips, as an interim measure.

2.5.2 Other Safety Countermeasures

The FHWA and state highway safety organizations have publicized safety countermeasures proven to reduce crashes, fatalities, and injuries at unsignalized intersections. Table 4 lists recently developed resources to assist states and local jurisdictions in improving intersection safety.

Table 4. Resources available to states and local agencies to improve safety at unsignalized intersections.

Date	Resource	Reference
2015	*Unsignalized Intersection Improvement Guide* (UIIG)	ITE
2015	*Crash Modification Factors* (*CMF*) *Clearinghouse*	FHWA
2014	*Manual for Selecting Safety Improvements on High Risk Rural Roads*	FHWA
2014	*Highway Safety Manual*	AASHTO
2011	*Intersection Safety: A Manual for Local Rural Road Owners*	FHWA
2011	*Modern Traffic Control Devices to Improve Safety at Rural Intersections*	TTI
2009	*Low Cost Safety Enhancements for Stop-Controlled and Signalized Intersections*	FHWA
2008	*Innovative Operational Safety Improvements at Unsignalized Intersections*	FDOT

The *Unsignalized Intersection Improvement Guide* (UIIG) is a web-based program that provides an interactive interface for evaluating unsignalized intersections and identifying opportunities to enhance their safety (Institute of Transportation Engineers [ITE] 2015). Appendix C provides examples of UIIG-recommended safety treatments. NTSB investigators used the UIIG to evaluate the US-98–SR-363 intersection for countermeasures to enhance the conspicuity of signs and provide improved warning to drivers. Numerous countermeasures could have improved safety at the intersection, including those described below.

2.5.2.1 Conspicuity Enhancements. Conspicuity refers to the extent to which a traffic control device attracts a driver's attention. The major factors that determine the conspicuity of a traffic sign are its size, angle of observation relative to the driver line of sight (eccentricity), and color and brightness relative to that of other objects in the visual environment.

During the final several miles of the SR-363 approach to the crash scene, the roadway was dark, with no artificial or ambient lighting. Although the dark roadway environment increased the saliency of the flashing red traffic control beacons, the lack of lighting reduced the bus driver's ability to observe roadway signs, such as the speed limit signs, the advance warning "STOP AHEAD" sign, and the stop sign. The ability of the driver to see these signs and other roadway markings was dependent on the efficiency of the bus headlamps in illuminating the traffic control devices and on the retroreflectivity of those objects.[84]

Given the conditions at the time of the crash, NTSB investigators determined that the following conspicuity enhancements described in the UIIG might have improved the bus driver's ability to recognize the need to stop at the intersection:[85]

- Stop beacon on the stop sign to increase its conspicuity.[86]
- Beacon on the advance warning sign to provide a visible signal of the sign and the approaching intersection.
- Light-emitting diode units, reflective panels on signposts, and retroreflective sheeting around the perimeter of signs to draw attention to the intersection.
- Duplicate regulatory or warning sign to draw attention to the need to stop.

2.5.2.2 Intersection Conflict Warning System. An intersection conflict warning system (ICWS) is an intelligent transportation system technology often used to warn motorists approaching an intersection of potential conflicts with other vehicles. The truck driver was unable to observe the bus approach the intersection until a collision was imminent because of the limited sight distance. An ICWS uses activated flashing beacons on intersection warning signs to identify

[84] NTSB investigators were unable to determine the headlamp beam pattern, aim, or intensity because of collision damage to the bus.

[85] The CMF Clearinghouse presents expected crash modification and reduction factors for each safety treatment (FHWA 2015).

[86] The stop sign was located 40 feet laterally from the center of the bus's lane of travel and was likely outside the driver's field of view during much of his approach to the intersection.

approaching and stopped vehicles and warn traffic accordingly. This countermeasure has also been found to be effective in warning drivers on a stop approach that they may run the stop sign based on their speed and trajectory.

2.5.2.3 Intersection Lighting, Control, and Geometric Design. The SR-363 approach to the crash location has no artificial lighting, and the intersection has no dedicated street lighting. Research has shown that the addition of artificial lighting can decrease the number of crashes, fatalities, and injuries at rural intersections (FHWA 2009c).

As a further safety measure, the implementation of all-way stop control or the addition of a traffic signal light might have alerted the truck driver to stop to avoid a collision.[87]

A roundabout intersection would have decreased the likelihood of an angle collision between the truck-tractor and the bus, and thus reduced the chance of fatalities and serious injuries. Roundabouts eliminate many of the potential conflict points typically associated with traditional intersections. They also enhance safety by reducing vehicle speeds both in and through the intersection and by changing the crash type from angle to sideswipe, which typically results in less severe crashes.

2.5.2.4 Summary. Although intersection safety treatments can be costly, such as the addition of a traffic signal device or the conversion to a roundabout design, many of the other countermeasures examined by the NTSB are relatively low cost. The NTSB concludes that though FDOT has taken steps to improve the safety of the US-98–SR-363 intersection, numerous other countermeasures are available to reduce crashes at the intersection.

2.5.2.5 Safety Recommendation. In 2015, following a similar unsignalized intersection crash near Moore Haven, Florida, FDOT conducted a postcrash safety analysis (NTSB 2016).[88] The Moore Haven crash occurred when a 15-passenger van traveling west on State Road 78 (SR-78) failed to stop at the T-intersection with US-27. The van traveled through the intersection, went off the roadway onto the grass shoulder on the north side of US-27, and vaulted across a canal. The collision resulted in eight deaths and 10 injured. The NTSB determined that the probable cause of the crash was the failure of the van driver to stop at the posted stop sign, possibly as a result of impairment from the use of a sedating antihistamine. Although the SR-78 approach to the intersection was well marked with a stop sign, an advance warning sign, and four sets of transverse rumble strips, FDOT installed a new "STOP AHEAD" sign with a flashing beacon, installed additional rumble strips, replaced the standard stop sign with an oversized version, and replaced retroreflective materials bordering the canal.

Based on the NTSB investigation of the US-98–SR-363 intersection crash, a similar safety assessment could improve safety in St. Marks. Therefore, the NTSB recommends that FDOT conduct an intersection safety analysis at the US-98–SR-363 intersection; and, if deficiencies are identified, implement safety enhancements.

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[87] All-way stop control refers to the stop signs being posted and facing all directions of travel such that each vehicle must stop before proceeding through the intersection.

[88] For additional details, see the NTSB public docket and search for HWY15FH008.

2.5.3 Unsignalized Intersections

2.5.3.1 Crash Problem. Crashes at unsignalized intersections are a national problem. From 2010 to 2015, more than 45,000 people were killed in intersections crashes—accounting for nearly one-quarter of all US traffic deaths. Of those fatalities, 30,139—more than 66 percent—occurred at intersections that are not under the control of a traffic signal (see table 5).

Table 5. Comparison of total traffic fatalities at all intersections vs. unsignalized intersections (2010–2015).

Year	Total US Traffic Fatalities	All Intersection Fatalities	Unsignalized Intersection Fatalities	% Unsignalized Fatalities
2010	32,999	7,363	4,994	67.8
2011	32,479	7,037	4,681	66.5
2012	33,782	7,560	5,019	66.4
2013	32,894	7,508	4,941	65.8
2014	32,744	7,585	4,961	65.4
2015	35,092	8,371	5,543	66.2
TOTAL	199,990	45,424	30,139	66.4

Source: National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System data.

The predominant type of crash at unsignalized intersections is an angle crash, where the driver on the stop approach either fails to stop at the posted stop sign or misjudges the distance or closing speed of a vehicle on the through approach. Because of the high speeds involved and the destructive nature of side impacts, unsignalized intersection crashes are often severe and result in fatalities and injuries.

On approach to an intersection, drivers typically have to attend to signs and signals, monitor and adjust speed and lane position, maintain awareness of other vehicles, scan for pedestrians and bicyclists, estimate the speed and distance of cross traffic, and make decisions accordingly. Given the brief time that drivers have to process a large amount of information, it is imperative that roadway designers and engineers provide clear and accurate guidance for navigating and avoiding crashes.

2.5.3.2 Safe System Approach. A safe system approach recognizes that roadway engineering countermeasures can be critical to prevent fatal and serious injury crash outcomes (United Nations 2011).[89] This approach accepts that people will continue to make mistakes, and roads should be designed to reduce the risk of crashes and to protect the public in the event of a crash.

The NTSB recommended the safe system approach in its investigation of a 1990 multivehicle collision in Sutton, West Virginia; in a followup safety study on highway work zone safety; and in the recent passenger vehicle speed study (NTSB 1991; 1992; 2017). Although the work zone signage and safety features provided adequate warning for a vigilant driver, they might have been inadequate for an inattentive or otherwise impaired driver. To address this problem, the NTSB advocated using the concept of the "design driver" when establishing traffic safety features. The concept assumes that some drivers may be impaired due to a medical condition, fatigue, or the use of alcohol or other drugs.

Low-cost safety improvements can address many of the common problems experienced at unsignalized intersections. In September 2017, the FHWA released six new infrastructure-oriented safety treatments and strategies to reduce fatalities and serious injuries on US highways.[90] One of the newly recommended countermeasures calls for the systemic application of multiple low-cost countermeasures at stop-controlled intersections. This approach to intersection safety may include, for example, the placement of enhanced signage and pavement markings at multiple unsignalized intersections to increase driver awareness and recognition of potential conflicts. The systemic approach has three components: analyze systemwide data to identify the problem, look for similar risk factors in severe crashes, and deploy on a large scale low-cost countermeasures that address the risk factors.[91] A recent study evaluated the overall safety effectiveness of the concurrent implementation of low-cost safety treatments and found a more than 10 percent reduction in fatal and injury crashes and a 15 percent reduction in nighttime crashes (Le, Gross, and Harmon 2017). Moreover, an economic analysis found a systemic application of multiple low-cost countermeasures to be very cost effective, with a benefit–cost ratio of 12:1.

Although the FHWA has released extensive information on the benefits of a safe system approach, and resources have been developed to guide local agencies through the safety improvement process, they are not widely used because of local jurisdictional obstacles. With more than 89,000 government entities in the United States, many local agencies do not have the dedicated safety staff or technical expertise to identify, implement, and advocate for appropriate safety treatments (FHWA 2014).[92] Moreover, many jurisdictions may be unaware of resources, such as the UIIG, which provides a step-by-step process to improve safety at unsignalized intersections. The NTSB concludes that a safe system approach that incorporates the systemic application of roadway engineering countermeasures can reduce crashes at unsignalized

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[89] The safe system approach is based on the 1997 Swedish Vision Zero initiative. A foundational principle of Vision Zero is that because humans as road users are fallible, transport systems must be forgiving. A crash should not cause death or serious injury.

[90] See the FHWA Office of Safety website on proven safety countermeasures, accessed September 28, 2017.

[91] See the FHWA Office of Safety website on a systemic approach to safety, accessed September 28, 2017.

[92] See the US Census Bureau census of governments for 2012, accessed September 23, 2017.

intersections, and transportation agencies would benefit from increased exposure to the UIIG and other similar resources.

2.5.3.3 Safety Recommendation. To increase recognition of the crash problem at unsignalized intersections and raise awareness of available resources, the NTSB recommends that the American Association of State Highway and Transportation Officials, National Association of Counties, National Association of County Engineers, National League of Cities, National Association of Towns and Townships, ITE, American Traffic Safety Services Association, American Society of Highway Engineers, and American Society of Civil Engineers, through media and outreach campaigns, inform their members of the prevalence of fatal crashes and serious injuries at unsignalized intersections; encourage them to use a safe system approach that incorporates the systemic application of roadway engineering countermeasures; and increase their awareness of available resources, such as the UIIG, to reduce intersection crashes.

2.6 Heavy Vehicle Fuel Tank Integrity

2.6.1 Fuel Tank Failure

The fire that consumed the truck-tractor and bus—and caused the truck driver to sustain fatal thermal injuries—was a direct result of the collision of the two vehicles. During the crash sequence, the front of the truck-tractor struck the left side of the bus, slightly behind the front axle.[93] This initial impact caused the rapid counterclockwise rotation of the truck-tractor and a secondary strike to the left side of the bus. At some point during the initial impact and rotation sequence, a sudden and catastrophic failure of the truck-tractor's right-side-mounted fuel tank resulted in a wide dispersal of diesel fuel.

Security video depicted an explosion of fire about this time in the crash sequence (see figure 3). Likely sources of ignition include friction and sparks generated by the impact and scraping of metallic materials or electrical arcing of possibly damaged wiring from the battery boxes on the bus.

Because of the extensive fire damage to the fuel tank, NTSB investigators could not determine the source of the tank rupture. The aluminum steps mounted to the exterior of the tank were consumed by fire and could not be examined for evidence of damage or interaction with the tank. A review of early on-scene photographs taken by the FHP showed that the right-side fuel tank became displaced and was relocated underneath the bus, which possibly occurred as a result of the impact with a utility pole (see figure 14d). Additionally, the crash caused the steel mounting straps, which secured the tank to the right frame rail of the truck-tractor, to break. The NTSB concludes that the structural failure of the truck-tractor's right-side-mounted fuel tank caused a dispersal of diesel fuel and initiated a postcrash fire, which resulted in fatal injuries to the truck driver.

[93] The battery boxes and associated electrical cables are located on the left side of the bus in the vicinity of the initial impact from the truck-tractor.

2.6.2 Other NTSB Investigations

Side-mounted fuel tanks have been breached in several other crashes investigated by the NTSB. In 2014, a truck-tractor with double trailers was traveling on Interstate 5 south in Orland, California, when it crossed a 58-foot-wide median, entered the northbound traffic lanes, and collided with a motorcoach (NTSB 2015a). A postcrash fire ensued; 10 people died, and 39 were injured. The investigation revealed that the catastrophic rupture of the truck-tractor fuel tank released fuel that sprayed into the interior of the motorcoach (see figure 17).

Figure 17. Postcrash fire following collision of truck-tractor and motorcoach in Orland, California. (Source: J. Lockett)

In 2010, a truck-tractor semitrailer was traveling on Interstate 65 south, near Munfordville, Kentucky, when it departed the left lane, entered the 60-foot-wide median, crossed into the northbound roadway, and collided with a 15-passenger van (NTSB 2011). As the truck-tractor traveled across the median, a cable barrier post punctured its right-side-mounted fuel tank, resulting in a 2-foot-long tear that leaked diesel fuel. Because of the crash and the ensuing fire, the truck driver sustained fatal injuries, which included smoke inhalation. The van driver and nine passengers succumbed to multiple, nonfire-related traumatic injuries.

On-highway operations—such as running over objects in the roadway—can also damage truck fuel system components (NHTSA 1989).[94] A 1981 crash near Lake Charles, Louisiana, showed the potential catastrophic results that can occur with breach of a side-mounted fuel tank (NTSB 1982). This crash sequence was initiated when a dislodged repair plate on the Calcasieu River bridge struck a truck-tractor semitrailer traveling on Interstate 10 east. As a result, the left-side-mounted fuel tank was compromised, and 75 gallons of diesel fuel leaked onto a

[94] This heavy truck fuel system study of these types of spills estimated 3,800 occurrences per year, which resulted in an estimated 200 crashes a year involving vehicles skidding in the spilled fuel.

half-mile section of the bridge. Twenty-six vehicles were involved in a series of skidding collisions. Three people died, and 18 were injured.

2.6.3 Fuel Tank Vulnerability

Extensive research on the integrity of fuel tanks and the prevalence of fires and explosions associated with the breaching of side-mounted fuel tanks has identified the tanks, tank mounts, and fuel crossover lines as the most likely fuel system components to be damaged in a crash (NHTSA 1989; 1988). During crash tests and comprehensive investigations of heavy truck accidents, a high percentage of truck inspections have shown extensive damage and loss of fuel system integrity to side-mounted tanks. Inspections have revealed punctures, ruptures, tears, and splits at tank seams.

Side-mounted fuel tanks are typically exposed near the outboard edge of truck-tractors. The approximate centerline height of many truck-tractor fuel tanks is 24 inches above ground, which corresponds to the height of many roadside barriers and automotive bumper heights (ranging from 13 to 23 inches) (Ferrone 2012). Additionally, the outer shell of most side-mounted fuel tanks is less than 1/8-inch-thick aluminum. Although the light-weight construction is preferable for improved fuel capacity and consumption, it compromises tank integrity in the event of contact with another vehicle, roadside object, or roadway debris.

2.6.4 Safer Alternatives

2.6.4.1 Current Research and Development. Although truck manufacturers have made some improvements to fuel tank systems, the design standards and construction of side-mounted tanks and their mounting location outside the frame rails and beneath the cab have not changed significantly in 50 years. Research has shown substantial opportunities for more effective protection of fuel tanks. For example, side-mounted fuel tanks can be relocated inward, away from the exterior of the vehicle, to provide additional protection (Friedman and others 2016; 2015). Other countermeasures include various tank modifications, strengthened tank mounts, stronger materials to increase puncture resistance, in-tank bladder systems, double-wall tanks, and the relocation of other truck components.

Advances in frame rail design for heavy trucks have provided increased opportunities to protect fuel storage systems. Alternative truck designs incorporating the fuel storage system within tapered frame rails have been tested using virtual models. Testing of a tapered frame integrated (TFI) fuel tank system and other alternative designs shows substantial reductions to the amount of crush energy sustained by the tanks (Friedman and others 2016; 2015). Figures 18 and 19 show two comparisons of a truck-tractor baseline model to an alternative design. In both examples, the vehicles are moving 50 mph at impact. The results of finite element simulation highlight the vulnerability of current fuel tank systems under the impact conditions studied.

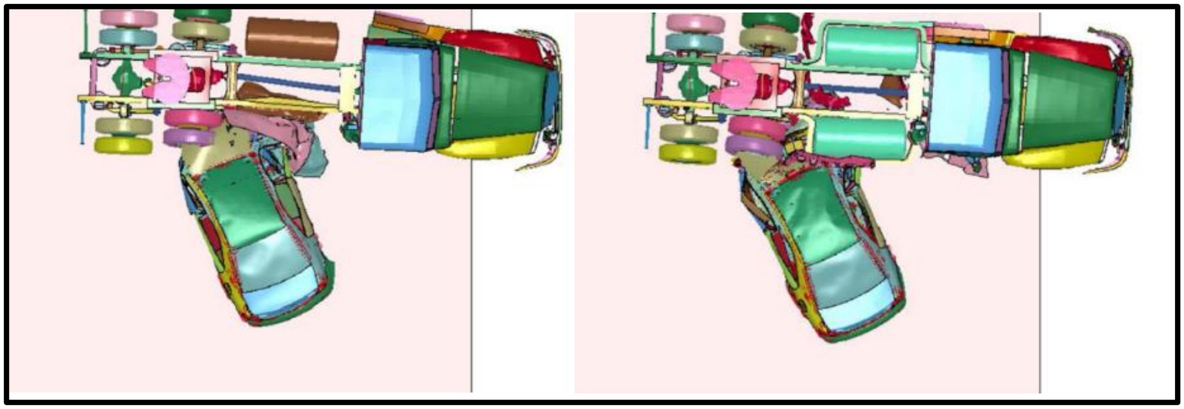

Figure 18. Virtual model test comparing baseline truck-tractor (left) to alternative design with frame rails outside of tank (right). (Source: Friedman and others 2015)

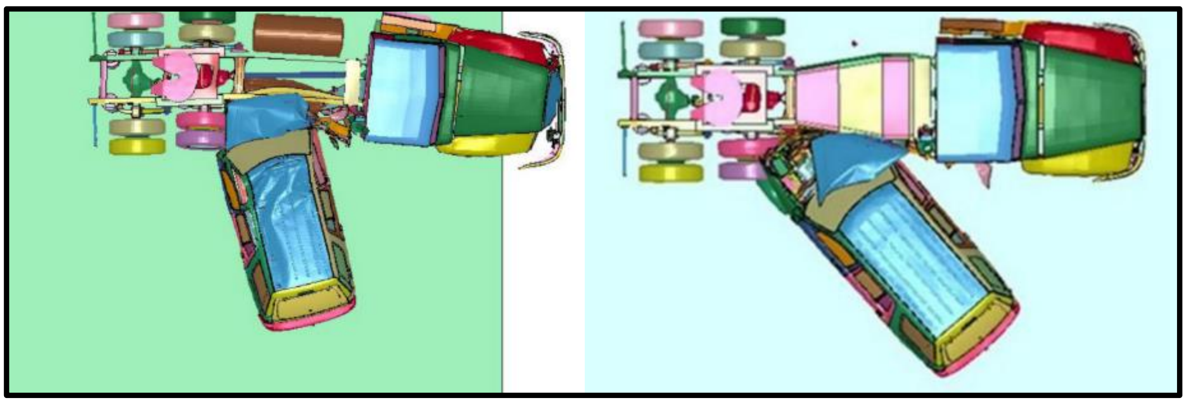

Figure 19. Virtual model test comparing baseline truck-tractor (left) to TFI design (right). (Source: Friedman and others 2016)

2.6.4.2 Industry Standards. The SAE International Truck Crashworthiness Subcommittee has developed standards for fuel systems (SAE J703) and fuel crossover lines (SAE J1624), which are incorporated into 49 *CFR* Part 393.[95] Key provisions of the standards are noted below:

- Title 49 *CFR* 393.65 requires that each fuel system be located such that (1) no part of the system extends beyond the widest part of the vehicle, (2) no part of a fuel tank is forward of the front axle of a power unit, (3) fuel spilled vertically from a tank while it is being filled will not contact any part of the exhaust or electrical systems, (4) fill pipe openings are located outside the vehicle's passenger compartment and its cargo compartment; and . . . Each fuel tank must be securely attached to the motor vehicle in a workmanlike manner.

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[95] SAE International, initially established as the Society of Automotive Engineers, is a professional association and standards developing organization. Heavy truck fuel system standard J703 was first issued in 1954 and was incorporated into the *CFR* in 1971.

- Title 49 *CFR* 393.67 provides specific requirements for the construction, testing, certification, and markings of tanks. Side-mounted fuel tanks must pass leakage tests, safety venting system tests, fill-pipe tests, and a drop test. The drop test requires that the tank be filled with a quantity of water having a weight equal to the weight of the maximum fuel load and then dropped 30 feet onto an unyielding surface so that it lands squarely on one corner.[96] Neither the tank nor any fitting may leak at a rate of more than 1 ounce of water (by weight) per minute.

Because of the length of time that J703 and J1624 have been in effect, they have been declared "stabilized" by SAE and are no longer subject to periodic reviews. Although the current regulations for side-mounted fuel tanks include leakage tests, safety venting system tests, fill-pipe tests, and drop tests, they do not appear to adequately reflect real world collision scenarios, such as documented at the St. Marks and the Orland, California, crashes (NTSB 2015a). The NTSB concludes that because of the construction and location of truck-tractor side-mounted fuel tanks, they are vulnerable to being compromised in a collision, and additional fuel tank integrity standards are needed.

2.6.4.3 Safety Recommendations. The FMCSA has authority over regulations contained in 49 *CFR* Part 393 regarding fuel tank integrity standards. NHTSA is responsible for developing crashworthiness standards. Therefore, the NTSB recommends that SAE International work with the FMCSA and NHTSA to improve truck-tractor side-mounted fuel tank crashworthiness to prevent catastrophic tank ruptures and limit postcollision fuel spillage, and develop and promulgate an updated standard. The NTSB issues corresponding recommendations to the FMCSA and to NHTSA.

2.7 Occupant Protection

2.7.1 Truck Driver Seat Belt Use

Based on the passenger's statement and inspection of the driver seat belt assembly, the truck driver was not wearing his lap/shoulder belt restraint system at the time of the crash. When the front of the truck-tractor collided with the left side of the bus, the truck driver's body was thrown forward and to the right. As the vehicle rotated counterclockwise and the right side of the truck-tractor struck the bus, the unrestrained driver was further displaced toward the right side of the cab. The driver was located in the passenger side seating area when the vehicle came to final rest. The passenger observed him bleeding and unresponsive.

The lap/shoulder belt is designed to restrain the driver in the seat, reduce the risk of injury-causing impacts, and allow the belted occupant to ride-down crash forces as the vehicle crushes and absorbs energy. Unrestrained, the truck driver likely struck the instrument panel, the steering wheel, and other surfaces, which resulted in incapacitating injuries. As a result, the NTSB concludes that had the truck driver been properly restrained by the available lap/shoulder belt, he would have remained in his seat during the crash sequence and likely avoided the injuries that prevented him from exiting the vehicle before the fire spread to the interior of the cab.

[96] This drop is equivalent to about a 30-mph impact.

The crash forces were survivable for the unrestrained passenger located in the rear of the cab. Additionally, because the driver's compartment was not compromised by intrusion, it provided sufficient survival space.

2.7.1.1 Enforcement. Verity Van Lines corporate policy requires all drivers to wear their seat belts when operating company vehicles. Additionally, 49 *CFR* 392.16(a) of the *FMCSRs* states that "no driver shall operate a commercial motor vehicle, and a motor carrier shall not require or permit a driver to operate a commercial motor vehicle, that has a seat belt assembly installed at the driver's seat unless the driver is properly restrained by the seat belt assembly."[97] The state of Florida has adopted the *FMCSRs*.

Florida has a primary enforcement seat belt use law that requires drivers and front seat passengers to be restrained when the vehicle is in motion.[98] Florida State Statute 316.614 is referred to as the "Florida safety belt law." It covers the operation of all motor vehicles except school buses, buses used for transporting passengers for compensation, farm tractors or implements of husbandry, motorcycles, mopeds, bicycles, or trucks with a gross vehicle weight rating (GVWR) exceeding 26,000 pounds—which, except for the application of the *FMCSRs*, applied to the accident vehicle. The Florida safety belt law does not apply to rear seat occupants of 18 years or older.

The exclusion of large trucks and other vehicles from the Florida safety belt law is concerning. Although state law enforcement officers have the authority to enforce federal regulations related to truck driver seat belt usage, the exclusion of trucks with a GVWR of more than 26,000 pounds from the state safety belt law likely affects enforcement. A recent observational survey showed that seat belt usage was higher in states governed by primary seat belt use laws (85 percent) than secondary seat belt use laws (78 percent) (FMCSA 2014).[99]

Recent statistics show that 593 truck drivers and 74 truck passengers were killed in crashes in 2015 (FMCSA 2017). Of the 667 fatalities among occupants of large trucks, nearly 44 percent were unbelted at the time of the crash. In a recent heavy truck crashworthiness study, researchers found that unbelted drivers are three times more likely to suffer fatal or incapacitating injuries in rollover crashes compared to belted drivers (NHTSA 2015).

2.7.1.2 Safety Recommendation. Seat belt use, regardless of the seating position or type of vehicle, can save lives. For more than 25 years, the NTSB has advocated legislation requiring the use of seat belts. As a result of a 2014 crash in Davis, Oklahoma, which resulted in four fatalities—and in which none of the passengers in the medium-size bus were restrained—the NTSB issued the following recommendation to the 50 states, the District of Columbia, and Puerto Rico (NTSB 2015b):

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[97] Florida State Statute 316.202 states, in part, that all owners and drivers of CMVs operated on public highways in the state—while engaged in interstate or intrastate travel—are subject to the rules and regulations contained in the *FMCSRs*.

[98] Per Florida State Statute 316.614, primary enforcement seat belt use laws allow enforcement officers to stop a vehicle with a driver/occupant not wearing a seat belt without the driver having committed any other traffic offense.

[99] A secondary enforcement law requires that occupants be stopped for another violation before being cited for nonuse of seat belts.

> Enact legislation that provides for primary enforcement of a mandatory seat belt use law for all vehicle seating positions equipped with a passenger restraint system. (H-15-42)

The state of Florida has not responded to Safety Recommendation H-15-42, which is classified "Open—Await Response."

Although it is unknown whether additional enforcement of seat belt use laws would have affected the truck driver's poor decision not to wear his safety belt on the day of the crash, research has shown that primary enforcement of seat belt use laws is effective. Because the Florida safety belt law excludes some vehicles, including trucks with a GVWR exceeding 26,000 pounds, the NTSB reiterates Safety Recommendation H-15-42 to the state of Florida.

2.7.2 Bus Occupants

NTSB investigators determined that the bus driver was wearing his lap belt and remained in his seat postcrash. Because the bus was not equipped with passenger seat belts, many of the bus occupants were thrown within the interior during the crash sequence. Although the bus was not being operated as a school bus at the time of the crash, it was originally designed to be a school bus. Large school buses are not required to have passenger seat belts, because the primary form of occupant protection is a passive system known as compartmentalization.[100] In this crash, the primary impacts were side impacts to the left side of the bus. The NTSB has found that compartmentalization does not adequately protect passengers during severe side impacts (NTSB 1999).

Emergency responders reported finding at least 10 injured passengers pinned between damaged seats in the rear intrusion zone. Additionally, three passengers were trapped in the front-loading stairwell under the collapsed loading door. A review of injuries to the fatally and most seriously injured passengers showed a predominance of left side injuries, including rib fractures, lung contusions, femur fractures, elbow fractures, and pelvic area fractures. These injury patterns are consistent with the most seriously injured being seated near the two left side intrusion zones when the truck-tractor collided with the bus. The NTSB concludes that the blunt force injuries sustained by the three fatally injured passengers in the bus, as well as the serious injuries to 14 passengers, were most likely related to the occupant seating locations in the area of direct impact and intrusion.

[100] (a) The 1979 Blue Bird bus—originally designed to transport school children—was later purchased to transport AG workers to farming locations. (b) Compartmentalization functions by forming a longitudinal compartment around the passenger with closely spaced, high-backed energy-absorbing seats that deform and absorb energy in a crash, allowing the passenger to ride down the collision. Compartmentalization was designed to contain unrestrained passengers within their seats during front and rear crashes.

3 Conclusions

3.1 Findings

1. None of the following were factors in the crash: (1) driver qualifications to drive a commercial motor vehicle, (2) driver distractions due to cell phone use, (3) medical condition of either driver, (4) bus driver impairment by alcohol or other drugs, (5) truck driver fatigue, (6) mechanical condition of either vehicle, (7) truck motor carrier operations, or (8) weather.

2. Although ethanol was detected in the truck driver's liver and kidney tissue specimens, it is possible that its presence was the result of postmortem production of ethanol.

3. The emergency response and fire suppression efforts were timely and effective.

4. The bus driver failed to stop at the US Highway 98–State Road 363 intersection, which is controlled by a stop sign and flashing red traffic control beacons, and proceeded directly into the path of the truck-tractor.

5. Because of the limited sight distance available to the truck driver on his approach to the intersection, he did not have sufficient time to react and take evasive action prior to colliding with the bus.

6. The bus driver's approach to the intersection provided sufficient visual cues and positive traffic control information for an attentive and alert driver to have recognized the intersection and the requirement to stop.

7. The bus driver was unfamiliar with the roadway environment and unaware that his route of travel on State Road 363 was not taking him to his intended destination.

8. The effects of fatigue caused by acute sleep deprivation and circadian factors likely contributed to the bus driver's lack of response to visual cues indicating the required stop at the intersection.

9. Billy R. Evans Harvesting, Inc., failed to follow adequate safety practices and to exercise oversight of its drivers and vehicles.

10. Driver fatigue and the failure of the motor carriers to follow adequate safety practices were key factors in both the Little Rock, Arkansas, and Ruther Glen, Virginia, crashes.

11. The Federal Motor Carrier Safety Administration missed the opportunity provided by the new entrant safety assurance program to ensure that Billy R. Evans Harvesting, Inc., had a programmatic commitment to safety, and the carrier entered the agricultural worker transportation industry without demonstrating an understanding of its safety responsibilities.

12. The US Department of Labor–Wage and Hour Division failed to conduct adequate oversight of Billy R. Evans Harvesting, Inc., operations prior to the crash and likely has insufficient resources, trained investigators, or proactive strategies to adequately ensure the safe transportation of migrant workers.

13. The Federal Motor Carrier Safety Administration and the US Department of Labor–Wage and Hour Division do not routinely collaborate regarding enforcement responsibilities and operations, nor have processes been established for the delivery of safety-critical information related to at-risk agricultural worker transportation carriers.

14. Targeted roadside enforcement campaigns in agricultural areas during peak harvest seasons can be effective in removing unsafe farm labor vehicles and drivers from the roadways.

15. Some motor carriers and farm labor contractors do not manage the fatigue of company drivers transporting agricultural workers, thereby placing workers—and the motoring public—at unnecessary risk of being injured in a crash.

16. Many states and local jurisdictions have developed programs to improve transportation safety for migrant agricultural workers, and the sharing of best practices would improve safety across the country.

17. Both the American Bus Association and the United Motorcoach Association are in a unique position to provide safe transportation services through outreach and engagement with agricultural employers, farm labor contractors, and the migrant worker population.

18. Had the Florida Department of Transportation reinstalled the transverse rumble strips before the crash or used temporary transverse rumble strips as an interim measure, the strips might have alerted the bus driver of his approach to the stop-controlled intersection ahead.

19. Although the Florida Department of Transportation has taken steps to improve the safety of the US Highway 98–State Road 363 intersection, numerous other countermeasures are available to reduce crashes at the intersection.

20. A safe system approach that incorporates the systemic application of roadway engineering countermeasures can reduce crashes at unsignalized intersections, and transportation agencies would benefit from increased exposure to the *Unsignalized Intersection Improvement Guide* and other similar resources.

21. The structural failure of the truck-tractor's right-side-mounted fuel tank caused a dispersal of diesel fuel and initiated a postcrash fire, which resulted in fatal injuries to the truck driver.

22. Because of the construction and location of truck-tractor side-mounted fuel tanks, they are vulnerable to being compromised in a collision, and additional fuel tank integrity standards are needed.

23. Had the truck driver been properly restrained by the available lap/shoulder belt, he would have remained in his seat during the crash sequence and likely avoided the injuries that prevented him from exiting the vehicle before the fire spread to the interior of the cab.

24. The blunt force injuries sustained by the three fatally injured passengers in the bus, as well as the serious injuries to 14 passengers, were most likely related to the occupant seating locations in the area of direct impact and intrusion.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the St. Marks, Florida, crash was the bus driver's failure to stop at the intersection due to inattention, likely caused by the effects of fatigue; and his unfamiliarity with the rural roadway, which was dark with limited lighting. Contributing to the crash were the failure of Billy R. Evans Harvesting, Inc., to exercise adequate safety oversight of the bus driver and the lack of effective oversight of the motor carrier by the Federal Motor Carrier Safety Administration and the US Department of Labor. Contributing to the severity of the injuries were the rupture of the truck's right-side-mounted diesel fuel tank, leading to a fast-spreading postcrash fire; and the failure of the truck driver to wear his lap/shoulder belt.

4 Recommendations

4.1 New Recommendations

As a result of its investigation, the National Transportation Safety Board makes the following new safety recommendations.

To the US Department of Labor:

> Audit the Wage and Hour Division oversight processes related to the safe transportation of migrant workers to determine, at minimum, if adequate resources are available to enforce the motor vehicle safety provisions of the Migrant and Seasonal Agricultural Worker Protection Act; if investigators are sufficiently trained to enforce transportation-related regulations; and if additional data-driven strategies are available to better focus limited enforcement resources. Once the audit is complete, require the Wage and Hour Division to resolve any identified issues. (H-17-54)
>
> Work with the Federal Motor Carrier Safety Administration to outline enforcement responsibilities and to establish a process for the routine sharing of safety-critical information, such as safety measurement system data, compliance review results, and new entrant safety audit information. (H-17-55)
>
> Develop and disseminate guidelines and training material for agricultural employers and farm labor contractors on the dangers of driving while tired and on strategies for managing driver fatigue. (H-17-56)
>
> Work with the Federal Motor Carrier Safety Administration to develop and disseminate guidelines for state oversight agencies on how to improve transportation safety for migrant and seasonal agricultural workers. These guidelines should include, at minimum, an overview of regulatory responsibilities, strategies for enhanced inspection and enforcement, suggestions for effective outreach and educational campaigns, and options for alternative transportation services. (H-17-57)

To the Federal Motor Carrier Safety Administration:

> Work with the US Department of Labor to outline enforcement responsibilities and to establish a process for the routine sharing of safety-critical information, such as safety measurement system data, compliance review results, and new entrant safety audit information. (H-17-58)
>
> Develop and implement a data-driven targeted enforcement plan, in collaboration with state Motor Carrier Safety Assistance Program partners, that incorporates recurring targeted roadside enforcement efforts in high-density agricultural regions during peak harvest seasons. (H-17-59)

Work with the US Department of Labor to develop and disseminate guidelines for state oversight agencies on how to improve transportation safety for migrant and seasonal agricultural workers. These guidelines should include, at minimum, an overview of regulatory responsibilities, strategies for enhanced inspection and enforcement, suggestions for effective outreach and educational campaigns, and options for alternative transportation services. (H-17-60)

Work with SAE International and the National Highway Traffic Safety Administration to improve truck-tractor side-mounted fuel tank crashworthiness to prevent catastrophic tank ruptures and limit postcollision fuel spillage, and develop and promulgate an updated standard. (H-17-61)

To the National Highway Traffic Safety Administration:

Work with SAE International and the Federal Motor Carrier Safety Administration to improve truck-tractor side-mounted fuel tank crashworthiness to prevent catastrophic tank ruptures and limit postcollision fuel spillage, and develop and promulgate an updated standard. (H-17-62)

To the Florida Department of Transportation:

Revise your *Standard Specifications for Road and Bridge Construction* to include guidance on the timely reinstallation of permanent transverse rumble strips during construction projects or the use of an alternative safety treatment, such as temporary rumble strips, as an interim measure. (H-17-63)

Conduct an intersection safety analysis at the US Highway 98–State Road 363 intersection; and, if deficiencies are identified, implement safety enhancements. (H-17-64)

To SAE International:

Work with the Federal Motor Carrier Safety Administration and the National Highway Traffic Safety Administration to improve truck-tractor side-mounted fuel tank crashworthiness to prevent catastrophic tank ruptures and limit postcollision fuel spillage, and develop and promulgate an updated standard. (H-17-65)

To the American Association of State Highway and Transportation Officials, National Association of Counties, National Association of County Engineers, National League of Cities, National Association of Towns and Townships, Institute of Transportation Engineers, American Traffic Safety Services Association, American Society of Highway Engineers, and American Society of Civil Engineers:

> Through media and outreach campaigns, inform your members of the prevalence of fatal crashes and serious injuries at unsignalized intersections; encourage them to use a safe system approach that incorporates the systemic application of roadway engineering countermeasures; and increase their awareness of available resources, such as the *Unsignalized Intersection Improvement Guide*, to reduce intersection crashes. (H-17-66)

To the American Bus Association and United Motorcoach Association:

> Initiate an outreach campaign to agricultural employers, farm labor contractors, and the migrant worker community to offer access to safe, reliable, and authorized motor carriers to meet their transportation needs. (H-17-67)

4.2 Previously Issued Recommendations Reiterated in This Report

As a result of its investigation, the National Transportation Safety Board reiterates the following safety recommendations.

To the Federal Motor Carrier Safety Administration:

> As a component of your new entrant safety audits, review with each new entrant motor carrier a structured process, such as the Safety Management Cycle, to (1) identify the root cause of safety risks and (2) maintain an effective safety assurance program. (H-12-31)

To the state of Florida:

> Enact legislation that provides for primary enforcement of a mandatory seat belt use law for all vehicle seating positions equipped with a passenger restraint system. (H-15-42)

4.3 Previously Issued Recommendation Reiterated and Reclassified in This Report

As a result of this investigation, the National Transportation Safety Board reiterates the following recommendation.

To the Federal Motor Carrier Safety Administration:

> Require all new motor carriers seeking operating authority to demonstrate their safety fitness prior to obtaining new entrant operating authority by, at a minimum: (1) passing an examination demonstrating their knowledge of the *Federal Motor Carrier Safety Regulations*; (2) submitting a comprehensive plan documenting that the motor carrier has management systems in place to ensure compliance with the *Federal Motor Carrier Safety Regulations*; and (3) passing a Federal Motor Carrier Safety Administration safety audit, including vehicle inspections. (H-03-2)

In addition, Safety Recommendation H-03-2 is reclassified "Open—Unacceptable Response" in section 2.4.3.1 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

EARL F. WEENER
Member

CHRISTOPHER A. HART
Member

T. BELLA DINH-ZARR
Member

Adopted: November 28, 2017

Members Weener and Dinh-Zarr filed the following statements.

Board Member Statements

Member Earl F. Weener
Concurring

Earl Weener 12/5/17

I agree with the conclusions and recommendations encompassed by this report. However, I believe it is worth clarifying one point raised in the report and testimony offered during the Board meeting. It seems clear that Florida has a seatbelt law which applies to drivers of commercial motor vehicles with a GVWR exceeding 26,000 pounds. While this law is not located within the so-called "seatbelt law," and is instead found in the portion of Florida code that deals with the regulation of commercial vehicles and drivers (primarily by adopting Federal regulations by reference), its location within state statute does nothing to lessen its applicability.[1] It also appears that Florida may intend for this law to function like the seatbelt law which applies to non-commercial vehicles, as a primary enforcement tool. If a failure to wear a seatbelt may be interpreted under Florida law as an "unsafe" condition pertaining to the driver, it appears that not just state authorized, but *all* local law enforcement officers may also stop and cite drivers. Therefore, my concern is not that there is a lack of mandatory seatbelt law for commercial drivers in Florida, but that the law itself may not be well understood or routinely utilized by law enforcement officers who do not specialize in commercial vehicle enforcement. Recent safety belt studies show that commercial driver seatbelt use is higher during peak traffic and on expressways than during light traffic and on other roadways.[2] Not coincidentally, specialized commercial law enforcement operations fall predominantly during weekdays and on interstates. While he was not asked why the driver sometimes failed to wear his seatbelt, the accident tractor-trailer passenger did report that the driver generally wore his belt. Therefore, had the driver believed that seatbelt enforcement activities on this type of roadway at this time of day were likely, he may very well have been belted and protected from the injuries which resulted in his death.

It is my hope that, however a state may choose to organize its laws, we will see a focus on training all law enforcement officers, state and local, to treat universal safety issues such as speeding, impaired driving, and seatbelt use, as just that, universal. All law enforcement officers should be aware of the potentially lifesaving traffic laws that are within their authority to enforce. And, all law enforcement officers should be trained and prepared to stop ***any vehicle,*** even large trucks and buses, pursuant to these laws if a violation places any roadway user at risk. While driver education and employer input are critical, I agree with staff that enforcement can play an important role in reducing traffic deaths.

Chairman Sumwalt and Member Dinh-Zarr joined this statement.

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[1] FLA.STAT. §316.302 (2016).

[2] FMCSA. 2017. *Commercial Motor Vehicle Safety Belt Facts.* Washington, DC: FMCSA.

Notation 57233 – Agricultural Labor Bus and Truck-Tractor Collision at US-98–SR-363 Intersection Near St. Marks, Florida, July 2, 2016

Board Member T. Bella Dinh-Zarr, Concurring (December 5, 2017)

In public health, and increasingly in highway safety, it is widely acknowledged that interventions designed to protect the most vulnerable, at-risk populations often protect *all* people. For example, highway professionals have found that interventions implemented to reduce deaths and injuries among older people, who are more likely to die when involved in a crash, have also prevented deaths and injuries among road users of all ages. The new recommendations in this report demonstrate that improving safety for the most vulnerable improves safety for all of us. I commend staff for their work on this report and for focusing on an often-overlooked population, agricultural workers. The recommendations will help these workers, and ultimately all travelers, reach their destinations safely. As in our recently released Speeding Study, this St. Marks report highlights two topics of great interest and importance: road design and vulnerable road users.

Road design is integral to crash prevention. Our report cites a 2010 study, conducted by Srinivasan, Baek, and Council in Minnesota and Iowa, that found a 39% reduction in fatal and incapacitating injuries at intersections with transverse rumble strips. A simple road design change, such as installation of rumble strips, could have prevented or mitigated this crash. Federal government agencies and professional highway organizations can, and should, foster these types of best practices in which jurisdictions take a systemic, data-driven approach to identifying locations that could benefit from roadway engineering countermeasures in order to reduce intersection crashes. Also, as with our speeding study, roadway intersection design is another area in which states, cities, and other jurisdictions may work to prevent highway deaths and injuries at a more local level. These types of interventions will serve to protect not only vulnerable road users, like the agricultural workers in this crash, but they will ultimately better protect all road users.

Chairman Sumwalt and Member Weener joined this statement.

Appendix A: Investigation

The National Transportation Safety Board was notified of this crash on July 2, 2016, and an investigative team was dispatched. Groups were established to investigate human performance; motor carrier operations; and highway, vehicle, and survival factors.

Parties to the investigation were representatives from the Federal Motor Carrier Safety Administration, US Department of Labor, Florida Highway Patrol, and Florida Department of Transportation.

Appendix B: Emergency Response Timeline

Time (July 2, 2016)	Responding Agency[a]	Action[b]
5:18 a.m.	WCSO dispatchers	Receive notification of crash from 911 system
5:25	WCEMS	Arrives on scene and starts triage
5:27	WCSO trained dispatcher	Calls Duke Energy Company (to have it shut off power grid) and was put on hold[c]
5:29	FHP	Arrives on scene, followed by 12 units, responsible for crash investigation
5:30	WCSO	Arrives on scene with 3 units, followed by 17 additional units
5:36	LCSO, LCEMS, and TFD	Receive requests for assistance with the crash
5:37	WCFD	Calls Duke Energy Company again (to have it shut off power grid) and was put on hold
5:37	Weems Memorial Hospital ambulance	Arrives on scene and transports 2 critically injured patients to Tallahassee Memorial Hospital
5:42	WCFD	Arrives on scene, establishes IC, and starts fire suppression but stops due to possible electrical wires
5:50	Duke Energy Company	Informs WCFD dispatch that a representative will be on scene in about an hour
6:06	LCSO	Arrives on scene with 3 units
6:02–7:27	LCEMS	Transports 17 patients to Tallahassee hospitals
6:15	ShandsCair	Arrives at landing zone
6:30	Duke Energy Company	Lineman arrives at nearest substation and receives order to open breaker to start de-energizing process
6:32	ShandsCair	Transports 1 critical patient to Tallahassee Memorial Hospital
6:11–6:50	WCEMS	Transports 14 patients to Tallahassee hospitals
6:40	Duke Energy Company	Lineman de-energizes system
6:55	Duke Energy Company	Lineman arrives on scene and informs FHP and WCFD personnel that lines were de-energized
7:07	WCSO	Informs IC that electric power is off, lines are communication lines and not a threat to first responders
7:38	TFD	Extinguishes fire

[a] WCEMS = Wakulla County Emergency Medical Services; WCFD = Wakulla County Fire Department; FHP = Florida Highway Patrol; LCSO = Leon County Sheriff's Office; LCEMS = Leon County Emergency Medical Services; ShandsCair = Shands Hospital medivac; TFD = Tallahassee Fire Department; WCFD = Wakulla County Fire Department; WCSO = Wakulla County Sheriff's Office.

[b] IC = incident command.

[c] Duke put WCSO dispatch on hold to contact lineman and supervisor on-call to get an estimated time of arrival.

Appendix C: UIIG Recommended Safety Treatments

Unsignalized Intersection Improvement Guide

Install a Stop Beacon

A flashing beacon that is placed on top of a STOP (R1-1) sign. The Stop Beacon consists of one or more signal sections of a standard traffic signal face with a flashing circular red signal indication.

This Stop Beacon has two horizontally-aligned signal indications.

This Stop Beacon comprises a single signal indication above the STOP sign.

This Stop Beacon has two vertically-aligned signal indications.

Check for Crash Modification Factor: CMF Crash Modification Factors Clearinghouse

Targeted Crash Types

- Right-angle
- Rear-end (minor road)

Problems Addressed

- Non-compliance with intersection traffic control devices
- Inadequate visibility of intersection or intersection traffic control devices

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with intersection traffic control or lack of awareness of intersection traffic control.
- Existing STOP sign is not conspicuous in surroundings.
- Recent change in traffic control or traffic regulation at the intersection.
- Poor visibility of the intersection from stop-contolled approach(es).

Considerations

- One or two red beacons may be installed—see MUTCD Section 4L.05 for additional guidance.
- A power source (typically solar or electric) will be required.
- The beacon may be actuated to flash red when approaching vehicles are detected through loop detectors.
- This strategy can be used in conjunction with other strategies to increase sign conspicuity.

Industry Standard

MUTCD

Section 2A.15: Enhanced Conspicuity for Standard Signs

Section 4L.05: Stop Beacon

Other Resources

Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT

Safety Evaluation of Flashing Beacons at STOP-Controlled Intersections, FHWA

Select Examples

Ridge Rd. & E. Four Mile Rd., Cheyenne, WY

Hoover Hill Rd. & Kennedy Rd., Trinity, NC

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 007

UIIG Unsignalized Intersection Improvement Guide

Install a Warning Beacon on a Standard Regulatory or Warning Sign

Addition of a Warning Beacon to provide emphasis to an existing regulatory or warning sign. Warning Beacons should not be used with STOP (R1-1), DO NOT ENTER (R5-1), WRONG WAY (R5-1a), or Speed Limit (R2-1) signs.

A single signal indication is used in this Warning Beacon that is mounted atop the Cross Road sign.

A pair of signal indications comprises this Warning Beacon.

The Warning Beacon supplementing this School sign along an uncontrolled major road approach includes two signal indications.

Check for Crash Modification Factor CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its surroundings.
- May be used at obstructions in or immediately close to the roadway.
- May be used to emphasize a change in traffic control or traffic regulation at the intersection (e.g., turning restrictions).
- Beacons shall not face conflicting vehicular approaches.

Considerations

- Determine power source—solar power or hard-wired.
- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- Take care not to overuse Warning Beacons as drivers may become accustomed to their presence and fail to respond as desired.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.

Industry Standard

MUTCD

Section 2A.15: Enhanced Conspicuity for Standard Signs

Section 4L.03: Warning Beacon

Other Resources

Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT

Select Examples

Atlantic Ave. & Ingram Dr., Raleigh, NC

Jetton Rd. & Meta Rd., Cornelius, NC

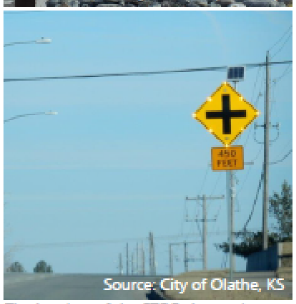
NC 55 & NC 111, Indian Springs, NC

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 017

UIIG Unsignalized Intersection Improvement Guide

Use LED Units Within a Regulatory or Warning Sign

The embedding of light emitting diodes (LEDs) within a sign's symbol, legend, or border to increase its conspicuity.



The borders of the STOP sign and Intersection Warning sign above are enhanced with LEDs, with both assemblies powered via the solar panel above the sign.

The conspicuity of this Stop Ahead sign is enhanced with LED units, which are particularly valuable during foggy conditions.

Check for Crash Modification Factor

CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its current surroundings.
- Poor sign visibility during low-light conditions.

Considerations

- LEDs can be set to flash or steady mode.
- LEDs have low power requirements and are typically powered by standalone solar panel units.
- Can be activated by vehicles or be on continuously throughout the day.
- Take care not to overuse LEDs in signs, as drivers may become accustomed to their presence and fail to respond as desired.
- Can be applied in conjunction with other treatments to increase sign conspicuity.
- LEDs must be red or white if used with STOP (R1-1) or YIELD (R1-2) signs, white if used with other regulatory signs, and white or yellow if used with warning or school signs

Select Examples

Ohio 303 & Indian Hollow Rd., LaGrange, OH

Eber Rd. & US 20A, Monclova, OH

Other Resources

Embedded LEDs in Signs, FHWA

Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT

Industry Standard

MUTCD

Section 2A.07: Retroreflectivity and Illumination

Section 2A.15: Enhanced Conspicuity for Standard Signs

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 018

UIIG Unsignalized Intersection Improvement Guide

Install Reflective Panels on Sign Posts

A strip of retroreflective material added to an existing sign post to enhance visibility of the sign during all lighting conditions.

Source: Lee Engineering, LLC


Source: PennDOT

Red reflective panels on the STOP sign supports make the stop condition more conspicuous.


Source: SCDOT

Yellow reflective panels on the two sign supports call attention to the warning of the impending stop control.

Check for Crash Modification Factor: CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Observed poor conspicuity of existing signs, particularly at night.
- Crash history or observed conflicts due to lack of awareness of the intersection or intersection traffic control, especially at night.
- Observations of non-compliance with intersection traffic control.

Considerations

- Color of strip should match the color of the background color of the sign, except strip color on YIELD (R1-2) and DO NOT ENTER (R5-1) signs shall be red.
- The retroreflective strip shall be at least 2 inches wide and shall extend the entire length of the post to within 2 feet of the ground
- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- The reflective post coverings/inserts should be replaced at the same frequency of the sign faces.

Industry Standard

MUTCD

Section 2A.15: Enhanced Conspicuity for Standard Signs

Section 2A.21: Posts and Mountings

Other Resources

South Carolina Case Study: Systematic Intersection Improvements, FHWA

Intersection Safety: A Manual for Local Rural Road Owners, FHWA

Select Examples

Marsol Rd. & Woodhurst Ave., Mayfield Heights, OH

Bates Crossing Rd. & US 276, Travelers Rest, SC

Lake Iola Rd. & Blanton Rd., Dade City, FL

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 019

Unsignalized Intersection Improvement Guide

Add Retroreflective Sheeting to the Perimeter of a Warning Sign

Addition of a solid yellow, solid fluorescent yellow, or diagonally striped black and yellow (or black and fluorescent yellow) strip of retroreflective sheeting around the perimeter of the warning sign to enhance the sign's conspicuity.

Source: VHB

The examples above illustrate the application of reflective perimeter sheeting to Cross Road, Pedestrian Crossing, and Stop Ahead warning signs.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Conditions Addressed

- Existing sign is not conspicuous in its surroundings.
- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device.

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Considerations

- Strip of sheeting must be at least 3 inches wide around the perimeter of the warning sign.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- Attempt first to remove visibility obstructions or sign distractions before using this treatment.

Industry Standard

MUTCD

Section 2A.15: Enhanced Conspicuity for Standard Signs

Check for Crash Modification Factor:

CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

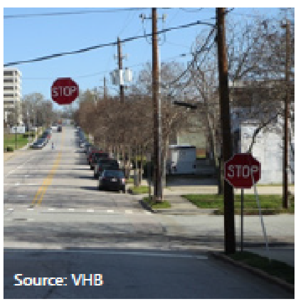
UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 020

Unsignalized Intersection Improvement Guide

Add a Duplicate Regulatory or Warning Sign

Installation of a second identical regulatory or warning sign on the left-hand side of the roadway or overhead to supplement an existing sign.

The left-side Cross Road sign and related enhancements promote driver awareness of the intersection.



The overhead STOP sign calls additional attention to the stop condition on this approach.

The second Stop Ahead sign and STOP AHEAD markings notify approaching road users of the impending stop.

Check for Crash Modification Factor: CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Non-compliance with intersection traffic control devices
- Vehicle conflicts with non-motorists
- Speeding

Conditions Addressed

- Crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control.
- Existing sign is not conspicuous in its surroundings.
- Wide or high-speed intersection approaches.

Considerations

- Remove any visual clutter that may be inhibiting driver's view of the existing sign.
- Take care not to overuse duplicate signing, as drivers may become accustomed to their presence and fail to respond as desired.
- This treatment can be used in conjunction with other treatments to increase sign conspicuity.
- When using left-side signing on a street without a median, a centerline should be considered.

Select Examples

- Auburn Knightdale Rd. & Grasshopper Rd., Knightdale, NC
- E. Cave Creek Rd. & Tom Darlington Dr., Carefree, AZ
- E. Maple St. & N. Central Ave., Nicholasville, KY

Other Resources

- South Carolina Case Study: Systematic Intersection Improvements, FHWA
- Stop Sign-Controlled Intersections: Enhanced Signs and Markings - A Winston-Salem Success Story, FHWA

Industry Standard

MUTCD

Section 2A.15: Enhanced Conspicuity for Standard Signs

Section 2A.16: Standardization of Location

Section 2A.17: Overhead Sign Installations

Section 2A.18: Mounting Height

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 016

Unsignalized Intersection Improvement Guide

Install Pavement Word and/or Symbol Markings

Pavement markings placed at or in advance of the intersection for the purpose of supplementing existing signs to guide, warn, or regulate traffic. Markings that would apply to unsignalized intersections include: STOP, YIELD, RIGHT (LEFT) TURN ONLY messages; lane-use and wrong-way arrows; and STOP AHEAD, YIELD AHEAD, SCHOOL XING, PED XING messages.

Source: PennDOT

These STOP AHEAD pavement markings supplement the Stop Ahead sign.

Source: PennDOT

These pavement markings remind approaching drivers of the speed limit and notify them of the impending intersection.

Source: Lee Engineering, LLC

The STOP pavement marking along this approach adds emphasis to the stop condition.

Check for Crash Modification Factor: CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate motorist guidance

Conditions Addressed

- Poor visibility of the intersection from approaches, especially when caused by vegetation or other obstacles along the road (e.g., parked vehicles).
- Crash history or observed conflicts caused by lack of awareness of intersection.
- In areas where the roadside may be "cluttered" with posted signs.

Considerations

- Symbol messages are preferable to word messages.
- Letters or numerals should be six feet or more in height. The longitudinal space between words or symbols should be at least four times the height of the characters (low speed roads) and not more than 10 times the height of the characters.
- Text presented in multiple lines should be applied such that the first word of the message is the first word a driver encounters, and no more than three lines are recommended.
- Non-slick material should be used for markings with large surfaces.
- Message may not be visible during the winter.

Industry Standard

MUTCD

Section 3B.20: Pavement Word, Symbol, and Arrow Markings

Select Examples

- E. Chestnut St. & Line St., Mifflinburg, PA
- Earlystown Rd. & Schempf Rd., Boalsburg, PA
- Periwinkle Way & Dixie Beach Blvd., Sanibel, FL
- NC 55 & NC 111, Seven Springs, NC

Other Resources

- Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT
- NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections
- Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 027

Install an Intersection Conflict Warning System (ICWS)

Unsignalized Intersection Improvement Guide

Intelligent Transportation System (ITS) technology used to warn motorists approaching an intersection of potential conflicts with other approaching vehicles. Such systems include detection of vehicles on the major road, minor road, or both.

This ICWS employs ground-mounted signing and Warning Beacons to warn major road drivers that one or more vehicles may be entering from the minor road.

This ICWS utilizes overhead signing and Warning Beacons to warn major road drivers that one or more vehicles may be entering from the minor road.

Targeted Crash Types

- Right-angle
- Rear-end (major road)

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Inadequate intersection sight distance
- Misjudgment of gaps
- Speeding

Conditions Addressed

- Crash history involving vehicles entering or crossing major road.
- Difficulty among drivers in determining appropriate gaps in traffic.
- Awareness of the intersection is lacking.
- High running speeds are typical of major road traffic.

Considerations

- There are applications designed for the major road approaches only, the minor road approaches only, or the approaches of both roads.
- Requires similar equipment to a traffic signal: controller, cabinet, detection devices (loops or video), and possibly LED message signs.
- Message should be simple and easily understood.
- Place at a distance from the intersection that would provide the approaching driver time to react.
- When ICWS design incorporates dynamic messages, some agencies program their devices to display random dots on the message screen when they are not working properly.

Other Resources

Stop-Controlled Intersection Safety: Through Route Activated Warning System, FWHA

Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT

NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections

Select Examples

US 24 & MO 15, Paris, MO

NC 42 & Castleberry Rd., Clayton, NC

Salem Church Rd. & Kingsland Rd., Richmond, VA

Check for Crash Modification Factor: CMF Crash Modification Factors Clearinghouse

UIIG Unsignalized Intersection Improvement Guide — Treatment ID No. 013

UIIG
Unsignalized Intersection Improvement Guide

Install Transverse Rumble Strips on the Intersection Approach

Application of depressions or raised areas across the surface of an approach lane to produce an audible and tactile warning of the impending intersection.

Raised transverse rumble strips warn drivers on this approach of the upcoming intersection.

Transverse rumble strips are installed ahead of this yield-controlled intersection.

Transverse rumble strips are applied along this multilane stop-controlled approach.

Check for Crash Modification Factor: CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)

Conditions Addressed

- Crash history or observed conflicts due to lack of awareness of the intersection.
- Citation history or observations of speeding on approach to intersection.

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Speeding

Considerations

- Use in combination with Intersection Warning (W2-1 through W2-8), Advance Traffic Control (W3-1 or W3-2), or Pedestrian Crossing (W11-2) signs.
- Noise generated from vehicles traversing the rumble strips can be an issue when residences are in close proximity to the intersection.
- Can require significant maintenance activities, especially on approaches characterized by high volumes of truck traffic.
- Raised rumble strips should not be used in areas where snowplowing is conducted.

Industry Standard

MUTCD

Section 3J.02: Transverse Rumble Strip Markings

Other Resources

Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT

Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA

Intersection Safety: A Manual for Local Rural Road Owners, FHWA

NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections

Select Examples

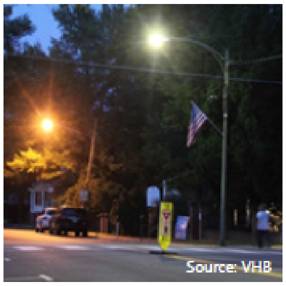
Crest Rd. & Allen Rd., East Flat Rock, NC

County Road 833 & FL 80, Clewiston, FL

Unsignalized Intersection Improvement Guide

Install Intersection Lighting

Installation of street lamps to illuminate the intersection at night.



Intersection lighting improves nighttime visibility of pedestrians.

Awareness of this intersection among major road drivers is increased by the street lighting.

Targeted Crash Types

- Right-angle
- Rear-end (major road)
- Rear-end (minor road)
- Pedestrian
- Bicyclist

Conditions Addressed

- History of nighttime crashes.
- Poor nighttime visibility of the intersection.
- Poor nighttime visibility of crossing pedestrians and/or bicyclists.

Problems Addressed

- Inadequate visibility of intersection or intersection traffic control devices
- Vehicle conflicts with non-motorists

Considerations

- Remote areas may be isolated from a power source.
- Especially helpful for intersections near parks, churches, schools, hospitals/clinics, and other facilities associated with nighttime activities.
- Provide adequate lighting for crossing pedestrians; wide streets may require lighting on both sides of the crosswalk.
- Consult local policies or legal code statutes on lighting.

Industry Standard

AASHTO Green Book

Section 3.6.3: Lighting (General)

Section 7-52: Lighting (Rural and Urban Arterials)

Section 9.11.5: Lighting (Intersections)

Other Resources

Reducing Late-Night/Early-Morning Intersection Crashes by Providing Lighting, FHWA

Lighting and Illumination, PEDSAFE

Cost Effective Local Road Safety Planning and Implementation, NACE

Intersection Safety: A Manual for Local Rural Road Owners, FHWA

Check for Crash Modification Factor:

CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 070

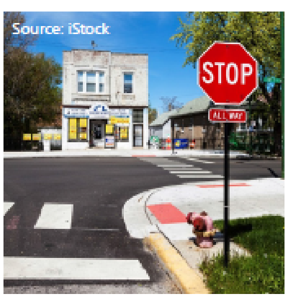
UIIG Unsignalized Intersection Improvement Guide

Implement All-Way Stop Control

Installation of STOP (R1-1) signs supplemented with the ALL WAY (R1-3P) plaque along all intersection approaches.

The ALL WAY plaque is mounted below the STOP sign.

A NEW plaque is used here to emphasize recently-implemeted all-way stop control.



The ALL WAY plaque here informs road users of the T-intersection's control type.

Targeted Crash Types

- Right-angle
- Bicyclist
- Pedestrian

Conditions Addressed

- Limited sight distance from minor road approaches.
- Crash history or observed conflicts involving turning or through vehicles from the minor road.
- Interim traffic control when a traffic signal is needed.
- Intersection with high pedestrian volumes.
- Intersection of two similar residential collector streets.

Problems Addressed

- Inappropriate intersection traffic control
- Excessive intersection conflicts
- Inadequate intersection sight distance
- Vehicle conflicts with non-motorists

Considerations

- Consider adding a NEW (W16-15P) plaque as a supplement to the STOP sign for an interim period.
- Consider installing advanced Stop Ahead (W3-1) signs and/or stop lines.
- Traffic volumes on both major and minor roads should be approximately equal.

Industry Standard

MUTCD

Section 2A.16: Standardization of Location

Section 2B.05: STOP Sign (R1-1) and ALL WAY Plaque (R1-3P)

Section 2B.06: STOP Sign Applications

Section 2B.07: Multi-Way Stop Applications

Section 2B.10: STOP Sign or YIELD Sign Placement

Other Resources

NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections

Select Examples

JC Galloway Rd. & Mobleys Bridge Rd., Grimesland, NC

Cornwallis Rd. & N. Shiloh Rd., Garner, NC

Prairie St. & 7th St., St. Charles, IL

Check for Crash Modification Factor

CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

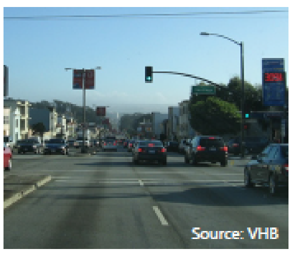
UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 003

UiIG
Unsignalized Intersection Improvement Guide

Install a Traffic Control Signal

Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. A signal may be considered when one or more of the nine warrants specified in the MUTCD are satisfied.

A traffic signal controls the vehicular movements at this T-intersection.



Traffic signals can be warranted by higher traffic volumes and proximity to a school crossing.

This traffic signal offers a protected phase for left turns from the major road.

Targeted Crash Types

- Right-angle
- Pedestrian
- Opposing left turn

Problems Addressed

- Inappropriate intersection traffic control
- Excessive intersection conflicts
- Poor operational performance
- Vehicle conflicts with non-motorists

Conditions Addressed

- Crash history or observed conflicts between turning vehicles and opposing through vehicles.
- Where one or more of the nine MUTCD warrants for a traffic signal are met (Section 4C.02).

Considerations

- Conduct a traffic control needs study and check warrants in the MUTCD (Section 4C.01).
- Design for all types of users at the intersection.
- Inform business and property owners near the intersection early in the process and ensure proper design of access points to the properties.
- May need to widen the intersection to provide left-turn lanes for signalization.
- Consider a roundabout as an alternative to installing a traffic signal.

Industry Standard

MUTCD

Section 4C.01: Studies and Factors for Justifying Traffic Control Signals

Other Resources

Signalized Intersections: Informational Guide, FHWA

Traffic Signals, PEDSAFE

Select Examples

Babylon Rd. & Limekiln Pk., Maple Glen, PA

Covered Bridge Rd. & Buffalo Rd., Clayton, NC

21st St. & Graham Ave., Windber, PA

Check for Crash Modification Factor: CMF CRASH MODIFICATION FACTORS CLEARINGHOUSE

UiIG Unsignalized Intersection Improvement Guide Treatment ID No. 008

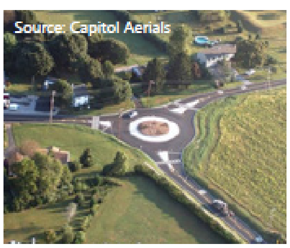
UIIG
Unsignalized Intersection Improvement Guide

Install a Roundabout

A form of circular intersection in which vehicles travel counterclockwise around a central island and entering traffic must yield to circulating traffic.

This aerial photograph shows an urban, four-legged roundabout.

Critical guidance is provided through pavement markings along this multilane approach.



This aerial photograph shows a rural, three-legged roundabout.

Targeted Crash Types

- Right-angle
- Opposing left turn

Problems Addressed

- Speeding
- Excessive intersection conflicts
- Inappropriate intersection traffic control
- Poor operational performance

Conditions Addressed

- Consider as an alternative to signalization.
- High crash frequency or severity, resulting in a need to reduce conflict points at the intersection.
- Congestion related to high numbers of left-turning vehicles.

Considerations

- May require additional right-of-way to construct a radius that accommodates a large design vehicle.
- Best at intersections having relatively balanced approach volumes or high numbers of left-turning traffic.
- Incorporating splitter islands and horizontal deflection into the design of the approach legs is key so that traffic entering the circular roadway is naturally encouraged to decrease its speed.
- Consider sight distance for all approaches when designing the aesthetics in the center. Truck aprons are also typically needed to accommodate off-tracking.
- Where dual approach or departure lanes exist, alternate accommodations are sometimes incorporated for visually-impaired pedestrians; these may include signals, PHBs, RRFBs, or raised crosswalks.
- In areas where roundabouts are uncommon, public involvement and education are necessary components for project success.

Industry Standard

MUTCD

Sections 2B.43 Roundabout Directional Arrow Signs

Section 2B.44 Roundabout and Circulation Plaque

Section 2B.45 Examples of Roundabout Signing

Chapter 3C. Roundabout Markings

AASHTO Green Book

Section 9.3.4: Roundabouts

Section 9.10: Roundabout Design

Other Resources

NCHRP 672: Roundabouts: An Informational Guide, FHWA

Innovative Operational Safety Improvements at Unsignalized Intersections, Florida DOT

NCHRP 500 Volume 5: A Guide for Addressing Unsignalized Intersections

NCHRP 613: Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections

Evaluating the Performance and Safety Effectiveness of Roundabouts, Michigan DOT

Roundabouts, PEDSAFE

Select Examples

Old Bethlehem Pk. & Station Rd., Quakertown, PA

VIDEO: Old Bethlehem Pk. & Station Rd., Quakertown, PA

Ulysses St. & S. Golden Rd., Golden, CO

E. Kings Hwy. & S. Pierce St., Eden, NC

Check for Crash Modification Factor: CMF Crash Modification Factors Clearinghouse

UIIG Unsignalized Intersection Improvement Guide Treatment ID No. 061

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